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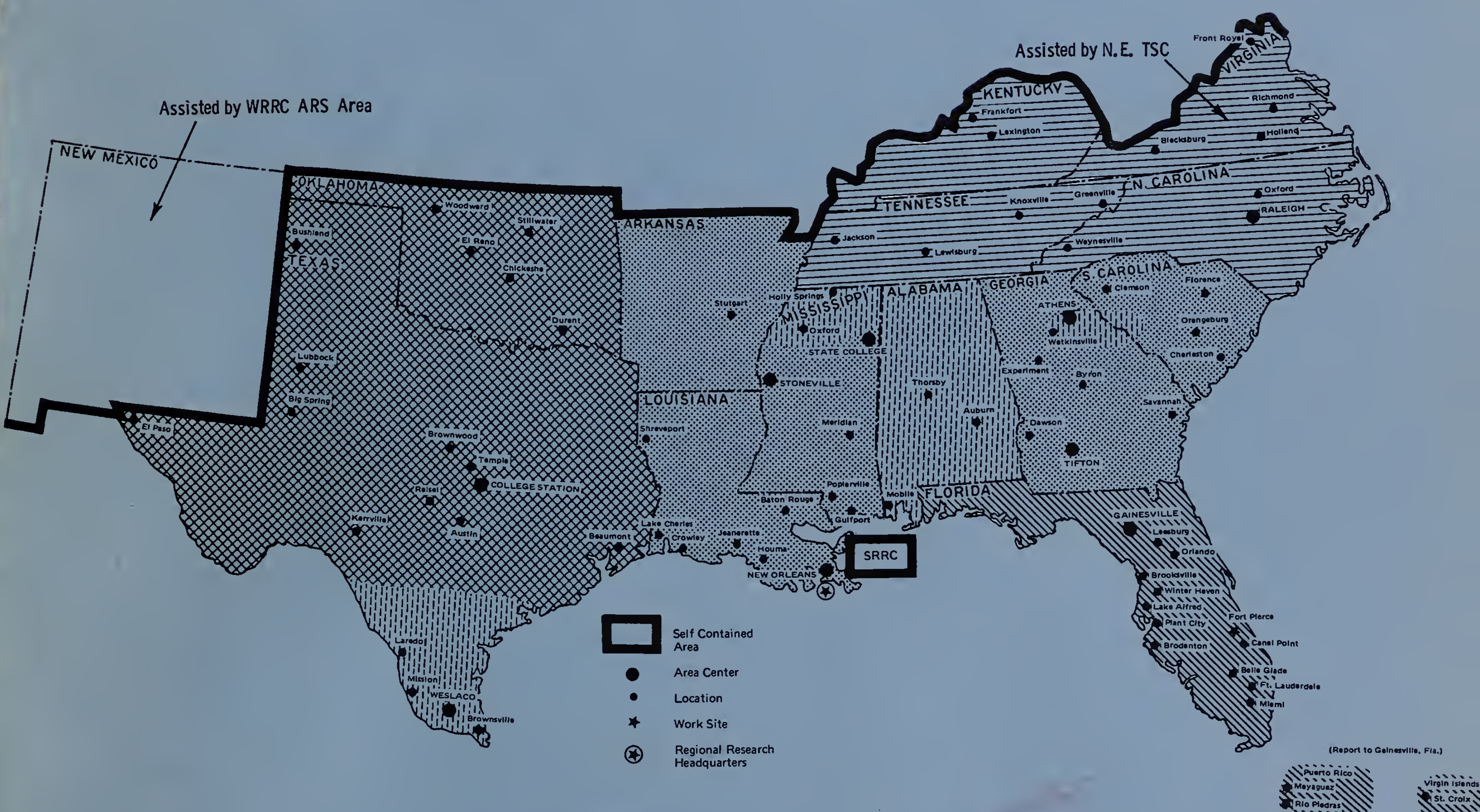
PROCEEDINGS
ARS-SCS SOUTHERN REGIONAL WORKSHOP ON WATERSHED PROBLEMS

april 16-18, 1974



S-ARS and SCS TECHNICAL CENTER WORK AREAS

SOUTH TECHNICAL SERVICE CENTER
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FORT WORTH, TEXAS

USDA-SCS-FORT WORTH, TEX. 1974

PROCEEDINGS

ARS-SCS SOUTHERN REGIONAL WORKSHOP

ON WATERSHED PROBLEMS

April 16-18, 1974

South Technical Service Center
Soil Conservation Service
Fort Worth, Texas

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H. L. Leithead
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W. J. Lloyd
Don Basinger
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Kenneth McManus
Olan W. Dillon, Jr.

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C. D. Ranney	Starkville, MS
Glenn W. Burton	Tifton, Georgia
Earl Burnett	Temple, Texas
B. A. Stewart	Bushland, Texas
Don Myhre	Mississippi State, MS
Pat McIlvain	Woodward, Oklahoma
C. L. Hoffpauir	New Orleans,Louisiana
J. S. (Sam) Rogers	Gainesville, Florida
James L. Fouss	Florence, South Carolina
Ron Menzel	Durant, Oklahoma
L. H. Allen, Jr.	Gainesville, Florida
Bill Fryrear	Big Spring, Texas
E. C. Bashaw	College Station, Texas
W. M. Bruce	Tifton, Georgia

Robert Blackburn	Ft. Lauderdale, Florida
R. W. Bovey	College Station, Texas
Zane F. Lund	Auburn, Alabama
Walter G. Knisel, Jr.	Athens, Georgia
J. E. Box	Watlsinaville, Georgia
Calvin K. Mutchler	Oxford, Mississippi
J. Roger McHenry	Oxford, Mississippi
Will A. Cope	Raleigh, North Carolina
Dean W. Winter	Raleigh, North Carolina
J. Nick Jones, Jr.	Blacksburg, Virginia
Edward B. Knipling	Stoneville, Mississippi
Donn G. DeCoursey	Chickasha, Oklahoma
William O. Ree	Stillwater, Oklahoma
W. C. Patterson	Athens, Georgia
Arthur W. Cooper	New Orleans, Louisiana
J. R. Johnston	College Station, Texas
Charles R. Swanson	Stoneville, Mississippi
Gaye Willis	Baton Rouge, Louisiana
Craig Wiegand	Weslaco, Texas
E. A. Taylor	Weslaco, Texas

SCS-ARS WORKSHOP
Fort Worth, Texas
April 16-18, 1974

Tuesday, April 16

8:30 Introductions and Purpose -- Jack Adair and J. R. Johnston

8:45 The South Technical Service Center, SCS -- William L. Vaught

9:20 The Southern Region, ARS -- Arthur W. Cooper

9:55 Break

10:15 The Environmental Impact Statement (EIS) -- Jack Adair, Head, Engineering and Watershed Planning Unit

11:00 Mid-Atlantic Area -- W. A. Winters, presiding

Raleigh, North Carolina -- W. A. Cope
Blacksburg, Virginia -- J. N. Jones

12:00 Lunch

1:00 Georgia-South Carolina Area -- W. M. Bruce, presiding

Tifton, Georgia -- Glenn Burton
Florence, South Carolina -- James L. Fouss

2:00 Athens, Georgia Area -- W. C. Patterson, presiding

Athens, Georgia -- Walt Knisel
Watkinsville, Georgia -- Jim Box

3:15 Break

3:30 Florida-Antilles Area -- Dean Davis, presiding

Gainesville, Florida -- J. S. Rogers
Ft. Lauderdale, Florida -- Robert Blackburn

Evening adjournment dependent on when we finish this portion of the agenda.

Wednesday, April 17

8:30	N. Mississippi-Alabama Area -- Dave Ranney, presiding
	Auburn, Alabama -- Z. F. Lund Auburn, Alabama -- W. R. Gill Oxford, Mississippi -- A. R. Robinson Starkville, Mississippi -- Don Myhre
10:00	Break
10:15	Continue with N. Mississippi-Alabama Area
11:15	Lower Mississippi Valley Area -- Ed Knipling, presiding
	Baton Rouge, Louisiana -- Guy Willis Stoneville, Mississippi -- C. R. Swanson
12:00	Lunch
1:00	Oklahoma-Texas Area -- W. O. Ree, presiding
	Chickasha, Oklahoma -- Donn DeCoursey Durant, Oklahoma -- Ron Menzel Stillwater, Oklahoma -- Bill Ree
3:00	Break
3:15	Woodward, Oklahoma -- Pat McIlvain Big Spring, Texas -- Bill Fryrear Bushland, Texas -- Bob Stewart
	Evening adjournment dependent on when we finish this portion of the agenda.

Thursday, April 18

8:30	Oklahoma-Texas Area, continue
	College Station, Texas -- E. C. Bashaw College Station, Texas -- R. W. Bovey Temple, Texas -- Earl Burnett
10:00	Break
10:15	Sub-Tropical Texas Area -- Ed Taylor, presiding
	Weslaco, Texas -- C. L. Wiegand
11:00	General Discussion -- Jack Adair
	Concluding Remarks -- A. W. Cooper
	Concluding Remarks -- W. L. Vaught

SCS-ARS WORKSHOP SPREAD SHEET FOR AGENDA DEVELOPMENT

Area	Location	Representative	Basic Soils	Soil Mgmt.	Soil Erosion	Water Mgmt.	Watershed Engr.	Environ. Quality	Plant Mgmt.	Biolog.
Mid-Atlantic	Raleigh, N. Carolina	W. A. Cope			X				X	
	Blacksburg, Va.	J. N. Jones		X	X					
Georgia-South Carolina	Tifton, Ga.	Glenn Burton							X	
	Florence, S. Carolina	James L. Fouss	X	X		X		X		
Athens, Ga.	Athens, Ga.	W. G. Knisel					X	X		
	Watkinsville, Ga.	Jim Box	X	X	X	X		X	X	
Florida-Antilles	Gainesville, Fla.	J. S. Rogers				X				
	Ft. Lauderdale, Fla.	Robert Blackburn						X		X
N. Mississippi-Alabama	Auburn, Ala.	Z. F. Lund						X		
	Auburn, Ala.	W. R. Gill		X						
	Oxford, Miss.	A. R. Robinson			X		X	X		
	Starkville, Miss.	Don Myhre		X		X				
L. Mississippi Valley	Baton Rouge, La.	Guy Willis	X			X		X		
	Stoneville, Miss.	C. R. Swanson		X				X	X	
Oklahoma-Texas	Chickasha, Okla.	D. G. DeCoursey			X	X	X	X		
	Durant, Okla.	R. G. Menzel	X					X		X
	Stillwater, Okla.	W. O. Ree					X		X	
	Woodward, Okla.	E. H. McIlvain							X	X
	Big Spring, Tex.	D. W. Fryrear		X	X	X				
	Bushland, Tex.	B. A. Stewart		X		X		X		
	College Station, Tex.	E. C. Bashaw							X	X
	College Station, Tex.	R. W. Bovey						X	X	
		(Bob Meyer)								
	Temple, Tex.	Earl Burnett	X	X	X	X	X	X		
Sub-Tropical Texas	Weslaco, Tex.	C. L. Wiegand		X		X			X	

ARS--SCS Workshop

April 16-18, 1974

Opening Remarks

J. R. Johnston - ARS:

Dr. Johnston said, in opening the meeting, that the ARS works with a number of agricultural agencies to provide technology. The purpose of the meeting is to "build on" a good relationship between ARS and SCS and to expand on research needs of SWCD-SCS. We have here a good mix of disciplines and should be able to generate a direct relationship of specific problems.

Kenneth G. McManus - SCS

Welcome! Director Vaught planned to be with us but was called on to represent the Administrator in a meeting in Mississippi. Hopefully, he will join us Wednesday.

We are pleased that we are able to continue these joint workshops started in late January at Chickasha which dealt with watershed research in the south region -- and the application of this research to some of our problems.

Reports from our staff who participated in the Chickasha meeting regarded the discussion and exchange of information as highly productive and mutually beneficial.

As indicated by Dr. Johnston, "A major objective of this workshop is to establish a close and effective working relationship between STSC staff and the research staff at ARS locations." We are very much interested in the research data and concepts of ARS -- especially as it relates to these 8 broader areas you will be reporting on during this workshop.

Perhaps our greatest need in improving our working relationship is that of making sure we communicate with one another. We feel there is mutual benefit from a staff member here at the TSC and a researcher reviewing the progress being made in a common interest area. For example, last month we had a meeting on correlation of our specification on wind erosion between two of our technical service centers. We extended an invitation to Neil Woodruff to work with us. We think our personnel have a better understanding of some of Neil's work, and we believe Neil has gained a better understanding of how we apply his research as we did the correlation, by discussing the alternative for adequate protection from wind erosion with SCD supervisors and SCD cooperators.

As a result of the Chickasha workshop, there have been followup visits to some of the research areas which have resulted in an exchange of good ideas. We believe that more contact through field trips or visits would prove to be highly productive -- SCS may have a need for information on a project and by contact with a research station may make use of research in the design and solution of a problem.

Opening Remarks (continued)

As we identify resource problems and opportunities in need of research information -- and as you set up research procedures, we would well profit by a discussion of what they will do in relation to our problems. In fact, a visit to the field to see the problem may be needed.

In the course of your discussions, I am sure examples will be pointed out of this kind of working relationship. I could point to some further examples of how our communications and contacts appear to be increasing. However, it is very evident our first meeting has resulted in some positive actions in this regard.

With the excellent program Jack and Rex have put together, I am sure we will have no problem realizing the objective in the discussions over the next two and one half days for continued effective working relationships.

In looking over the agenda for this workshop I see that I have some 35 minutes. Gentlemen, I won't talk that long, so that we'll have time for some questions from the floor.

Mr. Vaught and I thought that a joint SCS-ARS Workshop would be a productive and worthwhile endeavor. I am certain that it will be.

The Soil Conservation Service, established in 1935, has been charged with a tremendous responsibility. Soil and water are great natural resources that support us all. If soil is properly cared for, resource can be used and improved.

The research agencies in the Department of Agriculture have as part of their responsibility to generate new technology for the Soil Conservation Service. You, of course, obtain technology from many sources. The USDA Services are the Agricultural Research Service, Economic Research Service, and the research arm of the Forest Service. The Forest Service, as the name implies, does research applicable to the national, state, and private forest sector. The Economic Research Service is responsible for economic research related to agriculture. The Agricultural Research Service is the largest research unit and is responsible for research in plant sciences, entomology, animal sciences, veterinary sciences, marketing, nutrition, soil, water & air conservation and engineering. As most of you know, in July 1972 we had a complete reorganization of the Agricultural Research Service changing the structure from a discipline oriented management to a Region and Area management. We now have 4 Regions, Northeast, Southern, North Central, and Western, and each of these Regions is divided into geographic Areas headed by Area Directors. The system is working quite well and we feel gives us better control on keeping research in tune with society's needs. We feel that it is going to serve well in facing two situations that will be stressed in agriculture in the next several years - one is all-out production of food fiber for domestic use and export; the other is control of soil and water and air pollution. As you also know, we have changed rather suddenly from an economy in which we had a surplus of some basic agricultural products, such as wheat, corn and cotton, to a situation where we no longer have an excess of basic agricultural products. The agricultural sector of the economy is going to have pressure put on it for an all-out production. For example, it is estimated

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Presented by Dr. A. W. Cooper, Deputy Administrator, Southern Region, Agricultural Research Service, U.S. Department of Agriculture, New Orleans, La., before ARS-SCS Regional Workshop, Fort Worth, Texas, April 16, 1974.

that by 1980 we will need a third more land in soybeans alone. At present we have more than 75 million acres in soybeans. This means that we would need 25 million more acres for this crop. Our estimated idle acres, the 1973 crop season, was only 12 million acres. Also it is estimated that every hour we lose 40 acres of cropland to urbanization. During the 10-year period, 1959-1969, we lost 28.6 million acres of land to urban usage, transportation, and other non-farm uses.

It is quite clear then that we are going to need to grow more per unit area of land. This means that we need to improve our systems of production. This includes the whole picture, from land preparation, improved planning for better stands, improved weed control, improved insect control, improved plant disease control, and improved harvesting methods. In the production aspects I like to sum it up in good soil management.

Activities of the Soil Conservation Service are carried on through coordinated programs to determine the needs and capabilities of the land. That, I think, is the crux for conducting this Workshop. Today, tomorrow and Thursday you will be hearing from ARS researchers. They will present concise presentations of results and possible future directions of work in order to relate more directly to the needs of the Soil Conservation Service. Dr. J. Rex Johnston has suggested to the ARS participants that they allow adequate time for discussion and question and answer interchange with the SCS staff. We in ARS will be listening quite carefully to your needs. This Workshop should establish an improved working relationship between ARS and SCS. I hope that we establish a number of teams to work together to serve society's needs. I'm sure that we will. Over the next 2 1/2 days there will be presentations on basis soils, soil management, soil erosion, water management, watershed engineering, environmental quality, plant management and biology.

In the Southern Region ARS has a total of 109 scientist man years devoted to soil and water conservation-related research. Our biggest effort is in the area of watershed protection and management where we have about 29 scientist man years. We have about 20 scientist man years in the very important area of Soil, Plant, Water, Nutrient Relationships. And we have about another 20 scientist man years of effort in the area of Conservation and Efficient Use of Water. The remaining scientist man years are devoted to 4 other Research Problem Areas: Management of Saline and

Sodic Soils and Salinity; Drainage and Irrigation Systems and Facilities; Remote Sensing; and Alleviation of Soil, Water and Air Pollution and Disposal of Wastes.

This leads me into mentioning to you something about our organization.

The Southern Region for ARS has 8 Areas and 1 Center. The Center is the Southern Regional Research Center which concentrates on utilization & processing research of cotton & food crops. Because of the nature of its research missions it is not represented at this Workshop. The other 8 Areas are.

In Washington we have a National Program Staff. The National Program Staff functions as a program development, review and evaluation staff concentrating upon insuring the proper interaction, balance and distribution of research effort, and focusing on major policy and program issues. The NPS advises, consults and make suggestions, and helps coordination across region and helps develop national programs.

In Washington, Mr. Carlson, Assistant Administrator, ARS has an excellent relationship with the Soil Conservation Service. As you know we have had several groups meet of SCS and ARS personnel in the region.

We also have a very close working relationship with the Directors of the State Agricultural Experiment Stations; which is the other large research group of agencies doing soil conservation research.

We have a Southern Regional Research Planning Committee. The Committee is made up of 2 persons from ARS, 1 from the Forest Service, 1 from the Economic Research Service, 1 from the Cooperative Research Service, 4 from the State Agricultural Experiment Stations Committee, 1 representing the 1890 Institutions, 1 member from the Association of State Colleges and Universities Forestry Research Organizations, 1 from industry, and 1 from the Extension Service.

Dr. Jim Halpin, SAES Director-at-large, Clemson, S. C., and I are Co-Chairmen of this Committee.

We have some 32 Task Forces in the Southern Region. These Task Forces are made up of Federal and State scientists.

The results of this SCS-ARS Workshop, as with any Workshop or Task Force Report or Program Review, are made known to the National Program Staff. They in turn interface with

the other 3 Regions' Workshops and Program Reviews to give a National coordination of research.

Let me close here with a statement made by SCS Administrator, Kenneth E. Grant, referring to the"new land" going into crop production this year. He said, "Local Conservation Districts and USDA technical people are going to have to redouble efforts to help farmers and ranchers get additional cropland acres under a conservation plan and apply measures to stop excessive soil erosion. An SCS survey indicates that the expected soil loss could be reduced by 73 million tons if conservation practices were applied."

The only way ARS can help you obtain the technology you need is to maintain good communications with you.

Thank you.

DEPUTY ADMINISTRATOR

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Alabama - North Mississippi Area

Auburn, AL
Oxford (Holly Springs) MS
Mississippi State, MS

Athens, GA Area

Athens, GA
Watkinsville, GA

Florida-Antilles Area

Belle Glade, FL
Bradenton, FL
Brooksville, FL
Canal Point, FL
Fort Lauderdale, FL
Fort Pierce, FL
Gainesville, FL
Lake Alfred, FL
Miami, FL
Orlando, FL
Winter Haven, FL
Gurabo, PR
Mayaguez, PR
Rio Piedras, PR
Kingshill St. Croix, V.I.

Georgia-South Carolina Area

Byron, GA
Dawson, GA
Experiment, GA
Savannah, GA
Tifton, GA
Charleston, SC
Clemson, SC
Florence, SC
Orangeburg, SC

Mid-Atlantic Area

Frankfort, KY
Lexington, KY
Oxford (Waynesville)NC
Raleigh, NC
Greeneville, TN
Jackson, TN

Mid-Atlantic Area (Con't)

Knoxville, TN
Lewisburg, TN
Blacksburg, VA
Holland, VA
Richmond, VA

Mississippi Valley Area

Stuttgart, AR
Baton Rouge, LA
Crowley, LA
Houma, LA
Jeanerette, LA
Lake Charles, LA
Shreveport, LA
Gulfport, MS
Meridian, MS
Poplarville, MS
Stoneville, MS

Oklahoma-Texas Area

Chickasha, OK
Durant, OK
El Reno, OK
Stillwater, OK
Woodward, OK
Austin, TX
Beaumont, TX
Big Springs, TX
Brownwood, TX
Bushland, TX
College Station, TX
El Paso, TX
Kerrville, TX
Lubbock, TX
Temple, TX
Vernon, TX

Southern Regional Research Center

New Orleans, LA

Subtropical Texas Area

Brownsville, TX
Mission, TX
Weslaco, TX

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Lubbock
Big Spring
El Paso
Brownwood
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COLLEGE STATION
Reisel
Austin
Kerrville
Beaumont
Laredo
Mission
WESLACO
Brownsville
Stuttgart
Holly Springs
Oxford
STATE COLLEGE
STONEVILLE
Shreveport
Meridian
Thorsby
Auburn
Experiment
Lake Charles
Crowley
Jeanerette
Houma
Baton Rouge
Poplarville
Gulfport
Mobile
SRRC
New Orleans
Frankfort
Lexington
Knoxville
Greeneville
Jackson
Clemson
Florence
ATHENS
Watkinsville
Orangeburg
Charleston
Savannah
Dawson
TIFTON
GAINESVILLE
Leesburg
Orlando
Brooksville
Winter Haven
Lake Alfred
Plant City
Ft. Pierce
Bradenton
Canal Point
Belle Glade
Ft. Lauderdale
Miami
(Report to Gainesville, Fla.)
Puerto Rico
Mayaguez
Rio Piedras
Virgin Islands
St. Croix
Self-contained Area
Area Center
Location
Work Site
Regional Research Headquarters

(FROM FEDERAL REGISTER, NOVEMBER 19, 1973)

SCS

ACTION REQUIRING EIS

W/S RC&D

REQUIRE CONGRESSIONAL COMMITTEE APPROVAL

CHANNEL WORK PERENNIAL STREAM

HIGHLY CONTROVERSIAL

MAJOR ACTIONS

WILDLIFE HABITAT

MIGRATION ROUTES

HARDWOODS (BOTTOMLAND)

STREAM FISHERIES

ENDANGERED ANIMALS AND PLANTS

PERENNIAL STREAM

ARCHEOLOGICAL AND HISTORICAL

WATER QUALITY

WATER QUANTITY

APPEARANCE OF LANDSCAPE

NEGATIVE DECLARATION

Non-Major Federal Actions

Visual aids used by Jack Adair in ARS-SCS Workshop in discussing ways ARS Staff and ARS reports are needed in project planning and EIS.

ENVIRONMENTAL PLANNING

1. SET BROAD OBJECTIVES AND IDENTIFY ENVIRONMENTAL ISSUES.
2. INVENTORY RESOURCES.
3. ASSESS GAINS AND LOSSES OF EACH ALTERNATIVE: APPLY IN DECISION MAKING.
4. SELECT THE PLAN BASED ON:
   A. OBJECTIVES
   B. NATIONAL ECONOMIC DEVELOPMENT
   C. ENVIRONMENTAL QUALITY IMPACTS

SPONSORING LOCAL ORGANIZATIONS RETAIN RESPONSIBILITY FOR PROJECT DEVELOPMENT. OF COURSE, SCS INSISTS THAT ALTERNATIVES BE CONSIDERED AND THAT STRUCTURAL FEATURES FINALLY AGREED ON ARE DESIGNED AND INSTALLED IN AN ENVIRONMENTALLY ACCEPTABLE MANNER. ADVERSE CONSEQUENCES MUST BE AVOIDED, COMPENSATED FOR, OR MITIGATED. BUT MEASURES THAT WOULD ENHANCE THE NATURAL ENVIRONMENT FOR FISH AND WILDLIFE, ADD RECREATIONAL FACILITIES, AND THE LIKE, ARE NOT INCLUDED UNLESS DESIRED AND PARTIALLY FINANCED BY THE PROJECT'S SPONSORS. FROM THE MOMENT A PROJECT IS CONCEIVED UNTIL THE FINAL SEEDING IS ESTABLISHED ON DISTURBED AREAS, AND CARRYING ON INTO OPERATIONS AND MAINTENANCE, ENVIRONMENTAL CONSIDERATIONS ARE A PART OF THE PROCESS.1/

KEEP IN MIND THAT THE SPONSORS' JOB IS THE WORK PLAN AND THE SCS' JOB IS THE ENVIRONMENTAL STATEMENT. THUS, THE IMPORTANCE OF LOCAL SPONSORS AND THE SCS TEAM WORKING TOGETHER IN INVESTIGATION, PLANNING AND USING STUDIES OR REPORTS BY OTHER STATE AND FEDERAL AGENCIES.

1/ FROM: JOE HAAS

FOR EACH ECOSYSTEM:

I. DESCRIBE THE ENVIRONMENT - CLIMATE, GEOLOGY, LAND USE, SOCIAL, HYDROLOGY.

II. A. STRUCTURE - SPECIES, NUMBERS, IMPORTANT AND UNUSUAL - (WHAT'S THERE?)

B. FUNCTION - PRODUCTIVITY, CROPS, FOREST, RIVERS, NATURAL AREAS, TURN OVER AND RATE OF DECOMPOSITION - HOW IT WORKS.

C. DEVELOPMENT - HISTORY - CHANGES OVER TIME - LAND USES, ANIMALS, ORGANISMS - TRENDS.

III. LINKAGE - THIS IS THE RELATIONSHIP OF THE ECOSYSTEMS WITH INNER-ACTIONS.

IV. MAN'S DESIRES -

QUOTE, BILL DAVEY:

ENVIRONMENTAL PLANNING FOR DECISION MAKING RATHER THAN THE IMPACT IS THE KEY TO UPDATING PROCEDURES.

STUDY FOR FACTS

WHAT IS THE FUNCTION OF A SWAMP? IS IT AN AESTHETIC EXPERIENCE, HIGHLY PRODUCTIVE IN ORGANISMS, CORRIDOR OF MOVEMENT OF PLANTS AS WELL AS ANIMALS, A GIANT KIDNEY FOR CLEANING RIVERS, RECHARGER OF GROUND WATER, AN AREA FOR WILDLIFE, AN AREA FOR SONGBIRDS, AND MAN MADE?

THIS WHOLE PARAGRAPH WAS TO ASK: WILL OUR PLAN GIVE US THE ANSWER - NOT A GENERAL STATEMENT - BUT THE FACTS?

IN GENERAL, SEDIMENT IS NOT HARMFUL TO ORGANISMS. THE CRITICAL AREA STARTS AROUND 100 PARTS PER MILLION. SAND AND SILT IN THE STREAM BOTTOMS HAS REDUCED HABITATS. GREAT VELOCITY DESTROYS ORGANISMS. A MOVING SAND BED HAS VERY FEW ORGANISMS. REDUCING HIGH CONCENTRATION OF SEDIMENT AND HIGH VELOCITY IS BENEFICIAL TO ORGANISMS.

IT IS NOT ENOUGH TO USE OUR OLD FORMAT SUCH AS JUST WRITING A STATEMENT. WE MUST FOOTNOTE IT AND SAY FROM WHOM OR WHAT STUDY THE FACT WAS TAKEN. I AM SURE EVERY ONE OF YOU HAVE WRITTEN AN ARTICLE FOR A TECHNICAL SOCIETY AND YOU GAVE REFERENCES. SO IT OUGHT TO BE EASY FOR US TO MAKE THIS CHANGE. BE SURE IN GIVING THESE FACTS THAT YOU HAVE PUT BOUNDARIES ON THE ECOSYSTEM.

THE DEVELOPMENT OF PLANTS FOR EROSION CONTROL

Legumes for the Humid South[1/]

ARS personnel in the Crop Science Department at N. C. State University include five plant breeders and three physiologists. A number in other Departments work cooperatively with us or in less directly related research areas. This report will cover forage breeding and management work in the areas of erosion control and plant establishment. We will briefly cover (1) soil cover needs, (2) breeding a sericea variety for soil cover, and (3) other useful legumes, and (4) establishment methods.

Soil Cover Needs in the Humid South

SCS and ARS specialists are concerned first with large acreages of unused or abandoned farmland that need good crops for soil cover. However, in recent years there has been a rapidly expanding need in other areas. Disturbed industrial sites, especially building sites and mine spoil areas, require large investments in money and resources for proper stabilization. A recent survey by Turf Specialists revealed an impressive list for the State of North Carolina. The facilities involved include airports, cemetaries, colleges and universities, churches, highways, lawns (residential and commercial), parks, public schools, and golf courses. Total acreage was over one-half million and annual maintenance cost exceeded $120,000,000.

Legumes for soil cover. Legumes are used either in pure stand or in mixtures, especially legume-grass combinations. In either case the legume generally supplies nitrogen for vegetative growth. Most leguminous plants produce nitrogen compounds through a symbiotic relationship with the nitrogen-fixing bacteria of the genus *Rhizobium*. In pure stand up to 30 lb/A of nitrogen per month of vegetative growth may be produced. With annual legumes the nitrogen fixed in a few months can be adequate for year-round maintenance of the associated grass species. With the present energy crisis, legume nitrogen may become of increasing importance as a substitute for commercial nitrogen in maintenance of soil cover crops.

Breeding Sericea for Soil Cover

Sericea lespedeza has certain traits that make it a useful soil cover crop for many soils and disturbed sites in the South:

[1/] Will A. Cope, ARS Research Agronomist, Raleigh, N. C. Prepared for SCS-ARS Workshop, South Technical Service Center, Fort Worth, Texas, April 16-18, 1974.

1. It is a widely adapted, long lived perennial.
2. It is an attractive plant.
3. It is drought tolerant.
4. The root system is extensive and penetrates soil strata that are penetrated only slowly if at all by most plants.
5. Seedling establishment can often be accomplished on steep slopes where grasses fail to establish.

The plant breeder generally follows the policy of taking the best crop or variety available and improving it for specific purposes. An opportunity for improving sericea was recognized when it was successfully crossed with a related species characterized by a decumbent growth habit. The intermediate, spreading growth habit of the hybrid plants appeared ideal for the production of a thick cover in case of thin stands or for developing a dense canopy for greater competitive ability with weeds. The denser the canopy the fewer the weed seedlings that survive[as a result of increased shading]. However, segregating populations did not produce plants with both the vigor and spreading branch traits desired. A standard breeding program of backcrossing, intercrossing and selfing was carried out. Fifty selected inbreds were used to produce a synthetic variety that we named 'Caricea.' It is spreading branched in growth habit, at least as productive as common sericea, and superior in seed production. Seed have been distributed for numerous small plot tests for various soil cover conditions over the South.

<u>Other Legumes</u>

<u>Crownvetch</u>. Crownvetch is used widely on roadbanks in other areas, especially Pennsylvania. It is not well adapted for most of the South. The lower range for good growth appears to be the upper Piedmont. In the mountains and further north it should be a useful soil cover plant. Crownvetch does not persist in North Carolina under normal harvest practices for either hay or pasture.

Crownvetch is a vigorous perennial plant with exceptionally attractive flowers in late spring and summer. It requires one full year or more for establishment, but is competitive with most grasses where adapted. It actually tends to dominate and crowd out the grass. Individual crownvetch plants spread quickly from shoots that develop from fleshy lateral roots.

<u>Annual legumes</u>. Korean and Kobe lespedeza are widely used in mixtures. On roadbanks they serve a useful purpose by providing temporary cover, especially when the grass does not become established quickly. Other reseeding annual legumes could serve a similar purpose in many areas and provide nitrogen in a period when commercial sources are costly. Some commonly used annuals are crimson and arrowleaf clovers, bur clovers, hop clover, black medic, vetches, and sweet clover.

Establishing Legumes and Other Crops by Sod Seeding.

White clover is a standard component of improved pastures in North Carolina. Problems with clover persistence have reduced most of our pastures to pure grass. Now there is increasing interest in re-establishing clover in existing grass stands to improve forage quality and to supply nitrogen. A number of sod-seeding machines have been developed for the purpose of seeding clover without destroying the grass. With efficient sod-seeding machinery we could reseed the clover often enough to make it practical and economically feasible. Some of these machines have been perfected to the point that we feel confident in using them. With a vigorous grass it may be necessary to use a herbicide such as paraquat to weaken or kill part of the plants for successfully establishing the clover. Such equipment could prove valuable in establishing legumes, such as reseeding annuals, to improve vegetation for soil cover. Or they may be used to establish legumes or other crops for specific soil conservation use such as spot-seeding or for seeding without seedbed preparation.

SUMMARY OF SOIL MANAGEMENT RESEARCH

ARS, SOUTHERN REGION, MID-ATLANTIC AREA

(SCS-ARS Workshop, Ft. Worth, Texas-April 16-18, 1974) 1/

Soil and Water Conservation

Current ARS Projects

a. Strip mine reclamation
b. Solid waste disposal

Research Results:

1. In the Appalachian Region spoil materials are highly variable. They are practically devoid of organic matter and essential plant nutrients, and generally have a very low water-holding capacity. Studies to evaluate various soil amendments in neutralizing the acidity and toxic elements in the spoil material indicated that raw rock phosphate treatments and dolomitic limestone plus superphosphate treatments with blanket nitrogen applications produced the best ground cover and forage yields.

2. Species evaluation has included plant materials for stabilization but has stressed forage producation to provide economic utilization of the land surface in the mined areas. Grass species that have shown promise include: Ky 31 tall fescue, orchardgrass, timothy, bromegrass, weeping lovegrass, Bermudagrass, switchgrass, and redtop. Legumes include: crownvetch, birdsfoot trefoil, red clovers, white clovers, alsike clover, Kobe and sericea lespedizas and hairy vetch.

3. A surface mulch is essential for good germination and stand on difficult spoil material sites. Straw and pulp fiber are very effective, but the high cost of these materials often makes their use prohibitive. A study was conducted to evaluate the use of an *in situ* mulch. This was accomplished by seeding a small grain, rye, and killing it with a herbicide, paraquat, in the spring prior to establishment of the desired species and mixtures. Surface application of soil amendments in the killed rye was very satisfactory. (See attachment)

4. A technique for revegetating steep, outer slopes was evaluated and plans for a machine to construct the stairstep terraces or lateral grooves was proposed. The miniature seed ledges improve micro climate and help retain the seed, water and fertilizer in place on the steep slopes. (See attachment)

5. The response of various forage grasses on acid spoil under a range of soil amendment treatments, over a 3 year

1/ Presented by J. Nick Jones, Research Leader, ARS, Blacksburg, Virginia

period (See Table 1) indicates that the highest total yields were produced from rock phosphate. The highest yielding species was Ky 31 fescue which produced approximately 10 tons/ac of dry matter.

6. On refuse material (gob piles) weeping lovegrass and Kobe lespedeza provided the best ground cover.

7. Leachate analyses from solid waste disposal sites indicate great variability in composition, but most sites had a pH around 7.0.

8. Collecting and disposing of solid waste is the third largest expenditure of local governments.

9. Today 90% of our waste is disposed of in landfills or on the land.

10. Using the premise:

Solid waste = 800 lbs/cu. yd.

Waste-soil ratio = 4 to 1

Depth of fill = 10' to 12'

Waste/day/person = 5.8 lbs.

Then:

One acre of land is required for 10,000 people/year at 10' to 12' depth of fill.

11. Revegetation, management and plans for future utilization are needed on nearly all sites monitored in Southwest Virginia.

A TWO-STEP SYSTEM FOR REVEGETATION OF SURFACE MINE SPOILS[1]

J. Nick Jones, Jr., W. H. Armiger, and O. L. Bennett[2]

ABSTRACT

In surface mine spoil reclamation a year-round seeding program is needed. Since a favorable environment for seed germination and initial growth cannot be predicted, proper management of seedbed, application of appropriate soil amendments and mulch enhance the establishment of vegetation quickly. The principal objective of this study was to evaluate a two-step procedure: 1) establishment of initial ground cover to minimize erosion, with this cover later used as an *in situ* mulch; and 2) establishment of persistent herbage of acceptable quality for pasturage or hay. Small grain species rye (*Secale cereale* L.), wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) were drill seeded with fertilizer (67.2 kg N, 29.4 kg P and 56 kg K per hectare) in September 1970 on spoil with pH 3.8 to 4.0 in three separate blocks. In May 1971 the superior rye growth was killed with a herbicide, to provide the *in situ* mulch and then 3.63 metric tons of dolomitic limestone plus 56, 118 and 140 kg/ha of N, P and K, respectively were broadcast as a

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blanket application on the spoil area covered with the rye mulch. Selected forage legumes were surface seeded alone, and with a companion grass. Germination and seedling growth of the clovers and interseeded grasses were excellent. Seeding year herbage yields from four varieties of red clover (*Trifolium pratense* L.) and three varieties of white clover (*Trifolium repens* L.) averaged 3659 and 2375 kg/ha of dry matter respectively. Highest yield 6418 kg/ha was obtained from a mixture of sweet clover (*Melilotus officinalis* L.) and Kentucky 31 tall fescue (*Festuca arundinacea* L.), with a low of 1381 kg/ha from the Emerald variety of crownvetch (*Coronilla varia* L.). In 1972 ground cover by red clovers seeded alone averaged 72% and when seeded with a companion grass 34%, while white clovers averaged 74% and 29% respectively. Ground cover in 1973 for the single seeded legumes was slightly less averaging 69% for the red clovers and 60% for the white clovers. With companion grasses both red and white clovers increased to 39 and 49% respectively. Over the three year period herbage yields from red clovers have averaged 3060 kg/ha when established as a single species; with a companion grass the yield increased to 4361 kg/ha. For white clovers seeded alone, yields averaged 1899 kg/ha and 3039 kg/ha with companion grasses. Highest yield in the third year was from crownvetch at 5995 kg/ha. Determinations of pH in the 0 - 7.6 cm depth ranged from 5.2 to 5.9 and in the 7.6 - 15.2 cm depth from 4.7 to 5.3. The results indicate that establishment, ground cover and yield of various forage legumes on acid mine spoil is possible under a good management system.

Additional key words: *In situ* mulch, Herbicide, Ground cover, Yield, Clovers, Crownvetch, and Small grain.

Successful revegetation of surface mine spoils is dependent upon quick stabilization of freshly regraded spoils to control erosion and retain moisture (9). Preplanning prior to mining should include reclamation guides for revegetation of the spoils; whether for woodland, recreation, wildlife, or agricultural rehabilitation (3). Establishment of persistent vegetation depends on fertility and pH management, adapted species, seeding methods, mulch and soil water conditions (5). An important objective is the establishment of vegetation at any season of the year when the extraction of coal and the regrading operations are completed.

The physical and chemical characteristics of spoils resulting from surface mining coal operations vary widely and are determined by the parent rock material underlying a particular area. In southern Appalachia the parent rock materials are sandstones, which contain various amounts of high-sulfur-bearing pyritic roof coals and black shales. The pyritic material may cause high acidity in spoils after mining operations. On sandstone overburden spoils, surface crusting and moisture stress have resulted in poor germination and seedling development. Mulch applied at seeding has greatly increased germination and survival of turf plants (2). However, in many instances, the unavailability or high cost of mulching materials such as pulp fiber and straw prohibits their use on large surface mining areas.

Research with no-tillage corn production has shown that mulches consisting of _in situ_ grasses or small grain sods, killed with a herbicide, have increased water infiltration, conserved soil water, and reduced erosion (6,7). Revegetation of the spoil bench areas for agricultural use may best be obtained through a two-step seeding

program utilizing small grain as a mulch.

This research was conducted to determine the feasibility of using a two-step system where a small grain, planted for fast cover, serves as subsequent mulch for establishing forage legumes with and without companion grasses on surface mine spoils.

MATERIALS AND METHODS

The study was initiated on a regraded spoil bench area after surface mining of the Pocahontas #3 coal seam at White Oak Mountain, near Beckley, West Virginia. The pH of the spoil ranged from 3.8 to 4.0. A seedbed was prepared with a spring tooth harrow, and on September 10, 1970, three blocks of 0.14 ha each were drill-seeded to rye (Secale cereale L.), wheat (Triticum aestivum L.) and barley (Hordeum vulgare L.) at the approximate rate of 135 kg/ha. Fertilizer (67.2 kg N, 29.4 kg P, and 56 kg K per hectare) was drilled with the seed, but no lime was applied. On May 13, 1971, the block seeded to Abruzzi rye was killed by spraying with paraquat [1,1'-dimethyl-4,4'-bipyridinium bis (methylsulfate)] at the rate of 0.56 kg/ha (active ingredient). Prior to seeding, the experimental area received a surface application of 3.63 metric tons of dolomitic limestone (54% $CaCO_3$ + 43% $MgCO_3$), 56 kg N, 118 kg P, and 140 kg K per hectare. Selected legumes included four varieties of red clover (Trifolium pratense L.), three white clover varieties (Trifolium repens L.), alsike (Trifolium hybridum L.), yellow sweet clover(Melilotus officinalis L.) and Emerald variety of crownvetch (Coronilla varia L.). When seeded with a companion grass, Merion bluegrass (Poa pratensis L.) and creeping red fescue (Festuca rubra L.) were used with the three white clovers, and Kentucky 31 tall fescue (Festuca arundinacea L.) for all other grass-legume mixtures. Each legume species, with and without a companion grass, was broadcast seeded by hand on 3.66 x 3.66 m plots on May 20, 1971 in a randomized plot design with three replications. Seeding rates were approximately double those normally used on agricultural soils; for the red, alsike and sweet clovers the rate was 22.4 kg/ha,

for the white clovers 4.48 kg/ha and for the companion grasses 16.8 kg/ha. Herbage yields (dry weight basis) were calculated from a single harvest in the seeding year (61 x 61 cm samples) and two clipping harvests (86 x 274 cm samples) in the second and third years. Estimates of total ground cover and legume-grass percentage were averages from three observers. Total N in the ground composite samples of each legume species and legume-grass mixture was determined by the A.O.A.C. Method (1). Determinations of pH were made using a 1:1 ratio of soil and solution and a Zeromatic Beckman pH meter.

RESULTS AND DISCUSSION

Rye and wheat made exceptionally good fall growth. Barley failed to make sufficient growth for a satisfactory mulch. Winter-kill and apparant sensitivity to high concentration of aluminum in the spoil were contributing factors to the poor growth of barley (4). The *in situ* mulch from the Abruzzi rye averaged over 5600 kg/ha of dry matter and for Blueboy variety of wheat, over 4480 kg/ha. When allowed to mature, grain yields were 1280 kg/ha for wheat and 1080 kg/ha for rye.

Emergence and seedling growth of the various legumes and grasses seeded in the rye mulch were excellent. From the date of seeding to June 14, 1971, rainfall was measured at 4.85 cm. For the next 30-day period, it amounted to 4.32 cm and totaled 66 cm for the April-October growing season.

All species except crownvetch made excellent growth and yield during the seeding year (Table 1). The limited growth of crownvetch was anticipated as first-year seedling growth is slow (8). Average first year yields ranged from 6418 kg/ha of dry matter from a mixture of sweet clover and Ky 31 tall fescue to a low of 1381 kg/ha from the

Emerald variety of crownvetch. Yields for the four red clover accessions averaged 3659 kg/ha and 2375 kg/ha for the white clovers. Using a companion grass increased yields by 32% for the red clover mixtures and 63% for the white clover mixtures. Alsike clover was included because it appeared to be adapted to low Ca soils. Yields from Alsike, singly or with a companion grass, were intermediate.

Variations in ground cover were very apparent during the winter of 1971-72 with the best protective cover being from the grass-legume mixtures. The single seeded white clovers gave little erosion protection during the winter.

Examinination of root development and depth of penetration by the various legume species revealed effective root systems to a depth of 20 cm, however, nodulation was more prevalant in the top 7 cm.

To further compare species persistence, plant density determinations were made during the 1972 and 1973 growing seasons. These data (Fig 1) indicate in 1972 that all legumes seeded alone with the exception of sweet clover made up at least 60% of the total ground cover, but with a companion grass the legume fraction accounted for an average of 29% of the total ground cover. Significant differences as related to total ground cover utilizing Duncan's Multiple Range Test were found for Mammoth red clover 4, and sweet clover 10. When considering the legume fraction, all single seeded species (1 through 10) were comparable with the exception of sweet clover 10. However, when seeded with a companion grass the density of all legumes, except Pennscott red clover 13, was significantly lower.

In 1973 the density of the biennial red clovers was expected to decrease sharply, but the only occurrence was the Mammoth variety 4

(see 1973 data, Fig. 1). The decrease of Alsike 5, the perennial hybrid, was not anticipated. For the white clovers, Ladino 7, remained slightly below the common perennial white clovers. Encroachment by grasses ranged from 5 to 20 percent in all plots but sweet clover. Significant differences in total ground cover among the legume species with and without a companion grass occurred for Mammoth 4, Alsike 5, Ladino 7, and sweet clover 10. Of greater importance is the increase of the legume fraction in the grass-legume mixtures. It is generally agreed that a legume density above 40% will provide sufficient N for the grass.

Determinations of N made on composite samples taken at each harvest (Table 1) reflect stage of growth and forage quality of the various species. Crownvetch was least affected by seasonal conditions and management.

The analyses of variance on total herbage yields in each of the three years indicated significant differences among species and mixtures. Considerable overlap existed among species as exhibited by Duncan's Multiple Range Test. Because of the heterogenous acid mine spoil growth medium, the coefficient of variation was high, being 36% in 1971, 33% in 1972 and 30% in 1973. Herbage yields over the three-year period suggest that Kenland and Pennscott varieties of red clover were more adaptable to acid mine spoil conditions than Chesapeake or Mammoth. From the standpoint of forage production, Ladino clover was superior to common white clover, but for grazing, it was evident that the deer population preferred the white clover over all species under test. Although, the highest yield was obtained from a mixture of sweet clover and Ky 31 fescue during the first and

second years, it should be noted that crownvetch has the persistence and yield potential.

At the end of the initial growing season pH determinations averaged 6.3 for the 0-2.5 cm depth, 4.8 for the 2.5-7.6 cm depth and 4.0 for the 15.2-17.8 cm depth from surface applied lime. Terminal pH measurements averaged 5.5 for the 0-7.6 cm depth with a range from 5.2 to 5.9. For the 7.6-15.2 cm depth the average pH was 5.0 with a range from 4.7 to 5.3.

Under normal strip mining procedures, most of the soil erosion and the resulting pollution occur during the first few months after stripping before permanent soil cover is established. By using fast growing species such as small grain or summer annuals, the disturbed land areas can be quickly stabilized and the vegetative growth from these species can later serve as mulch for interseeding permanent grasses and legumes. Rye appeared to be better adapted to the low pH conditions of the surface mined area selected than either wheat or barley.. Rye is known to be tolerant to high concentrations of Al and Mn, which are prevalent in most low pH spoils. The use of a herbicide to kill the rye is justified; 1) to provide the desired mulch, 2) to insure profile soil moisture and 3) to better utilize optimum seeding dates. Also, this *in situ* mulch is only one-third to one-eighth as expensive as mulching materials applied at time of seeding. The two-step procedure where small grain gives quick ground cover and later serves as a mulch for interseeding more permanent species could be used on many disturbed land surface areas such as surface mining, highway construction or urban developments.

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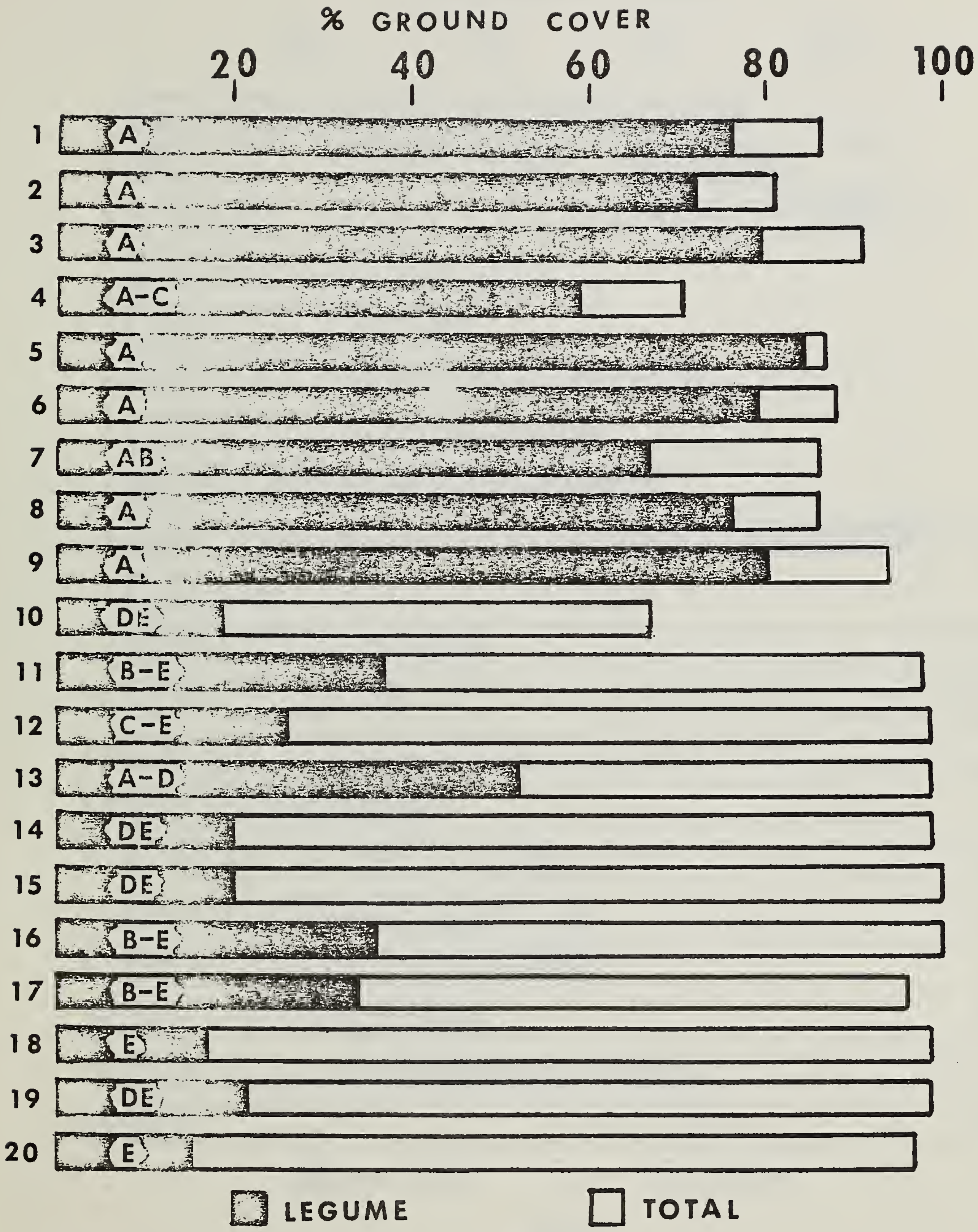
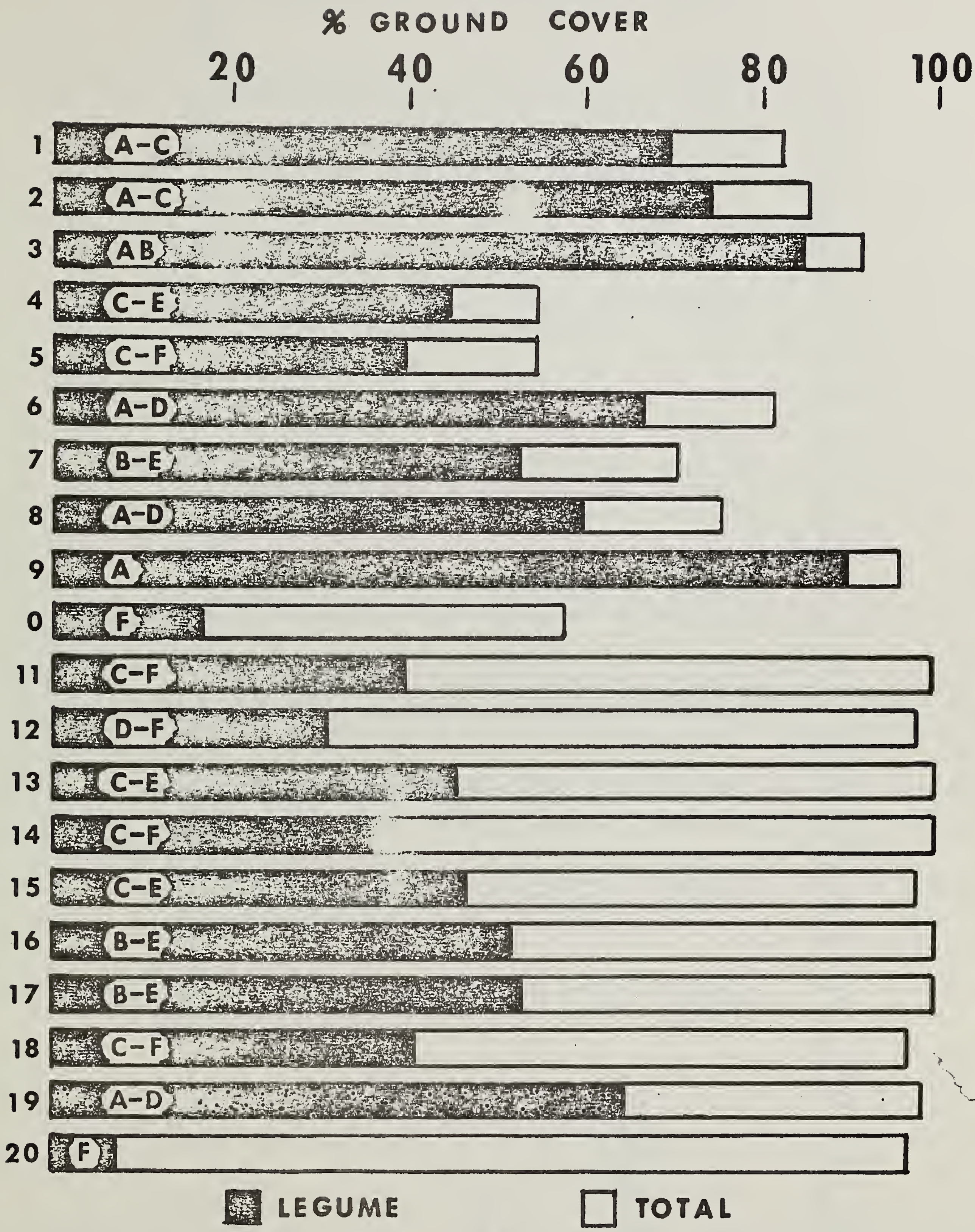


% GROUND COVER
20
40
60
80
100
1
A
2
A
3
A
4
A-C
5
A
6
A
7
AB
8
A
9
A
10
DE
11
B-E
12
C-E
13
A-D
14
DE
15
DE
16
B-E
17
B-E
18
E
19
DE
20
E
LEGUME
TOTAL

1972



% GROUND COVER
20
40
60
80
100
1
A-C
2
A-C
3
AB
4
C-E
5
C-F
6
A-D
7
B-E
8
A-D
9
A
0
F
11
C-F
12
D-F
13
C-E
14
C-F
15
C-E
16
B-E
17
B-E
18
C-F
19
A-D
20
F
LEGUME
TOTAL

1973

Table 1. Yield and total N from legumes grown with and without companion grasses on surface mine spoil.

		Total N (3 rep composite)					Herbage Yield*			
		1971	1972		1973					
	Species and Mixtures	Seeding Year	1st Harvest	2nd Harvest	1st Harvest	2nd Harvest	1971	1972	1973	3-yr total
		%					kg/ha			
1	Red clover - Chesapeake	3.22	2.54	2.56	2.03	1.89	2,876 b-d	1,570 ef	2,816 b-d	7,262
2	Red clover - Kenland	3.23	2.78	2.66	2.58	2.06	4,562 a-d	2,720 b-f	4,234 a-d	11,516
3	Red clover - Pennscott	3.65	1.98	2.62	2.86	2.19	4,177 a-d	2,088 d-f	3,773 a-d	10,038
4	Red clover - Mammoth	2.83	2.42	2.48	2.46	2.00	3,021 b-d	2,241 d-f	2,548 cd	7,810
5	Alsike clover	3.64	2.72	3.70	2.20	1.98	2,465 cd	2,797 b-f	3,525 a-d	8,787
6	White Dutch clover	3.43	1.56	2.50	2.59	2.79	2,331 cd	843 f	2,012 d	5,186
7	Ladino clover	3.50	1.34	2.26	2.45	2.10	2,115 cd	1,341 f	3,084 a-d	6,540
8	Wild White clover	4.00	1.40	2.16	2.84	2.56	2,680 cd	823 f	1,820 d	5,323
9	Crownvetch	2.52	2.52	3.46	3.06	3.22	1,381 d	1,973 ef	5,995 a	9,349
10	Sweet clover (yellow)	2.50	2.02	2.16	1.78	1.98	3,298 a-d	2,395 c-f	1,801 d	7,494
11	Chesapeake + Ky 31 Fescue	2.72	1.56	2.24	1.58	1.86	3,935 a-d	4,941 ab	5,305 a-c	14,181
12	Kenland + "	2.29	1.38	1.88	1.35	1.98	3,657 a-d	4,865 ab	5,612 ab	14,134
13	Pennscott + "	2.53	1.42	2.34	2.09	1.97	5,727 ab	3,965 b-e	5,785 ab	15,477
14	Mammoth + "	2.52	1.40	2.24	1.87	1.96	6,059 ab	4,482 a-d	4,080 a-d	14,621
15	Alsike + "	2.18	1.36	2.48	1.75	1.86	3,191 a-d	4,769 ab	4,023 a-d	11,983
16	White Dutch + Merion Bluegrass Creeping red fescue	3.67	1.64	1.98	1.87	2.34	3,128 a-d	1.877 ef	3,544 a-d	8,549
17	Ladino + "	3.03	1.78	2.14	1.79	2.54	4,921 a-d	804 f	5,095 a-c	10,820
18	Wild White + "	3.65	1.50	1.90	1.44	2.54	3,595 a-d	1,570 ef	2,854 b-d	8,019
19	Crownvetch + Ky 31 Fescue	1.98	1.26	2.06	2.45	2.98	2,859 cd	3,966 b-e	4,731 a-d	11,556
20	Sweet clover + "	1.92	1.58	2.10	1.00	1.40	6,418 a	6,742 a	3,333 a-d	16,493

* Average of three replicates. Any two columed yields having a letter in common are not significantly different. Level of significance .05 in 1971; .01 in 1972 and 1973.

SEED LEDGES IMPROVE STABILIZATION OF OUTER SLOPES ON MINE SPOIL

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Coal occurs in essentially horizontal layers. Surface mining in mountainous terrain leaves land in two major categories: Level benches in the same plane as the coal layer, and above and below these benches, slopes that are often steeper than the original terrain. In the past, laws governing surface mining were inadequate and have resulted in neglect of these disturbed land areas which commonly remain unvegetated and become potential pollution hazards. Today, legislative measures in almost all States require the restoration of land disturbed by surface mining. With proper shaping, such disturbed land may be useful for grazing, forestry, recreation, and other purposes, and possibly be made more attractive and useable than the original terrain.

In the West Virginia Surface Mining Act, the wide variations in location and terrain conditions, both topographical and geological, were recognized and the necessity of providing effective, beneficial, and equitable solutions to these problems was stressed (3).

The West Virginia Legislature, in an effort to control erosion, amended their Surface Mining Act in 1971 to require mulching of all disturbed areas where the slopes exceed 20° from horizontal (1).

Steep outer slopes occur in much of the mountain terrain, and stabilization against erosion continues to be one of the complex problems associated with reclamation of surface mine areas. Establishment of persistent vegetation is the only practical way to stabilize the earth materials on these steep slopes. Unless such steep slope areas are revegetated immediately after disturbing the soil and natural vegetation, serious erosion results (Fig. 1), destroys emerging vegetation, and leaves permanent, deep gullies and growing scars. The long outer slopes could be broken into shorter slopes by bulldozer-constructed terraces, but the cost would be high. Earth-moving operations can be reduced by using the terrace principle, if stairstep size terraces are constructed. Such miniature terraces provide ledges for holding water, seed, lime, and fertilizer that improve the microclimate for germination and growth and help develop deep, plant root systems.

Published data on the seed ledge technique on difficult slopes are limited. McKee et al (2) used horizontal scarification on highway slopes as early as 1962. Woodruff et al showed that lateral grooves are desirable and often necessary for rapid and satisfactory establishment of vegetation on steep slopes of highway cuts (4).

This paper reports the results of two years of study on revegetating the steep slopes of surface mined areas and it recommends procedures and equipment needed.

GENERAL PROCEDURE

Steep, long, outer slopes generally are formed by the earth materials being pushed off the bench and allowed to slide down the hill until they reach a natural angle of repose. During this process, the larger stones slide faster and further than the finer materials. This particle size distribution is probably the primary cause of soil water deficiencies and limited success of revegetation on the lower part of some slopes. To alleviate the problem, some of the coarsest materials could be pushed off the bench first and the finer materials used as a surface

cover for the entire length of such slopes and provide soil material with relatively good water-holding characteristics.

The chemical composition of the spoil material determines the need for fertilizer and lime amendments and the choice of ecologically adapted plant species. Plant species selected should have deep penetrating root systems that anchor the unstable spoil quickly and effectively. If the bench area is constructed so that it slopes down toward the highwall (back of the bench), surface water will not flow from benches and down the slope. Water retention through soil infiltration on slopes is necessary for establishing and maintaining vegetative cover.

In the experiments, a series of stairstep terraces (grooves) were constructed with hand tools on the steep outer slopes of the research plots. The terraces were 18 to 24 inches apart down the slope, on the contour and paralled to the main bench. A schematic drawing of this technique, shown in Fig. 2 was used with experimental plantings of vegetative cover (Fig. 3).

In 1971, two mountain sites near Beckley, West Va., were selected for evaluation of experimental stairstep terraces on outer slopes. The White Oak Mountain site had an initial pH of 4.1, and the Bolt Mountain site had a pH of 2.9. The slope percentage at each location was not accurately determined but exceeded 65%.

At both locations the experiments were conducted on a split plot design with three replicates. In the main treatments, three rates of rock phosphate were compared with superphosphate in 9' x 28-ft. plots, as shown in Table 1. The plot widths were located at the top of the slope, and the length extended down the slope from the bench. Each plot was divided (9 x 14 ft.) and randomly seeded to a special legume either directly or by transplanted greenhouse grown seedlings spaced about 18 inches apart on the stairstep terraces. Birdsfoot trefoil 'Empire' was used at White Oak Mountain, and both trefoil and crownvetch 'Penngift' were used at Bolt Mountain. The entire area of each of the experiments was overseeded with weeping lovegrass to provide quick cover and stabilization.

On the more acid spoil at Bolt Mountain, 5 tons/acre of dolomitic lime was broadcast on all plots. At White Oak Mountain, a rate of 2 tons/acre was used. Fertilizer that included 50 lb. N, 150 lb. K_2O, and 1 lb. molybdenum per acre was applied uniformly over all plots. Straw mulch was used to improve germination and seedling development. The mulch was very beneficial at White Oak, but high winds left very little of it in place at Bolt Mountain.

RESULTS

The handset birdsfoot trefoil plants made excellent growth at White Oak Mountain. Germination and subsequent plant development on the seeded plots were also very good. Results of seeding establishment and early growth are shown in Fig. 4. Plants established in the grooves appeared to shade and otherwise protect the steeper slopes, and full vegetative cover by midsummer (Fig. 5) gave excellent erosion control.

Complete ground cover was obtained on both experiments at Bolt Mountain. However, weeping lovegrass made up more than 75% of the cover during the seedling year. Transplanted crownvetch plants made satisfactory growth with all four fertility treatments. Figure 6 shows a comparison of plant growth from 4 tons/acre of rock phosphate with that from 320 lb./acre of P_2O_5. The initial growth from direct seeding of the special legumes was encouraging.

Data on dry matter yield as calculated from clipped samples harvested in early fall in 1971 and 1972 are given in Table 1. The average dry-matter yield in 1971 on the rock phosphate plots at White Oak Mountain was 4,132 lb./acre. This

compared very favorably with an average of 4,474 lb./acre on the superphosphate plots (320 lbs. P_2O_5). Likewise, the average yield from direct seeding was 4,416 lb./acre and 4,020 lb./acre from the transplanted plots. The average yield in 1972 from rock phosphate was 6,563 lb./acre and from superphosphate 7,020 lb./acre, with similar yields from direct seeding and transplanting. Yield samples in 1971 were separated to determine the legume-grass ratio. From the seeded plots, birdsfoot trefoil made up 37% of the yield as compared with 36% from the transplanted plots. In 1972 estimates indicate a legume increase to 82% from direct seeding and 72% from transplanting. The extra work and cost involved in transplanting the legumes is not necessary when a good stand of seeded weeping lovegrass and Ky 31 fescue can be developed to protect the legume seedlings.

Average yields in 1971 from the more acid spoil at Bolt Mountain were approximately 3,000 lb./acre for both the birdsfoot trefoil and crownvetch seedings; however, the legume fraction made up only 18% of the vegetation during the seedling year. Yield variations within each fertility treatment for seeded and transplanted plots were strongly associated with the stand and response of the overseeded weeping lovegrass. Average yield differences between rock phosphate and superphosphate treatments were small. In 1972 the average yield from rock phosphate was 4,172 lb./acre and only 3,610 lb./acre from superphosphate in the birdsfoot trefoil study. With crownvetch, yields averaged 4,595 and 4,633 lb./acre, respectively. In the birdsfoot trefoil study the legume increased to 28% from both the direct seeded and transplanted plots, while in the crownvetch study the legume increased to 41% and 50%, respectively.

The terraces constructed on the outer slope face before seeding helped greatly in obtaining a quick plant cover. With the terrace technique and possibly the use of a wider range of herbaceous plants, seedlings may be established faster during the height of the growing season. The advantage of improved soil-water relations in the grooves, plus the banding effect of the seed and fertilizer, apparently caused rapid plant establishment for soil stabilization and erosion control.

Construction equipment, such as hydraulic truck cranes, or excavator-grading crawlers with telescoping booms, could be modified easily and equipped with a yardarm for making the terraces. With a hydraulic motor, scarifying tools could operate back and forth across the yardarm. To eliminate side draft, the scarifying feet could operate simultaneously from each end of the yardarm and move toward the boom. A sketch of a proposed concept is shown in Fig. 7. Limiting terraces to the length of the yardarm (16 or 20') would form closed-end basins and would eliminate the need for precise contouring and costly engineering.

Other concepts may be developed to aid seedling establishment on outer slopes, such as the use of annuals or small grains to provide a quick cover which later serves as an _in situ_ mulch. Germination of small grain could be activated by presoaking in water for 12 to 24 hours before using a hydroseeder with pulp fiber added.

Table 1 - Average Dry Matter Yield - Outer Slope Studies

Utilizing Stairstep Grooves

		Dry matter yield (lb./acre)					
		White Oak Mt.		Bolt Mountain			
		Weeping Lovegrass and Birdsfoot Trefoil		Weeping Lovegrass and Birdsfoot Trefoil		: Crownvetch	
Phosphorus treatments	Methods of legume establishment	1971	1972	1971	1972	1971	1972
2 Tons Rock	Seeded	5,445	5,333	3,031	3,846	2,783	3,702
	Transplanted	3,398	7,964	2,175	3,422	4,525	6,508
3 Tons Rock	Seeded	5,677	7,156	*	*	*	*
	Transplanted	2,311	6,428				
4 Tons Rock	Seeded	3,446	7,020	3,534	4,758	3,702	4,454
	Transplanted	4,518	5,477	2,966	4,653	2,031	4,294
6 Tons Rock	Seeded	*	*	3,262	4,342	2,455	4,518
	Transplanted			2,111	4,014	2,679	4,094
320 Lbs. P_2O_5 (Super)	Seeded	3,094	7,020	3,510	3,934	3,182	3,174
	Transplanted	5,853	7,020	1,719	3,286	3,990	6,093
Average all Treatments:		4,218	6,677	2,788	4,032	3,168	4,605

* These rates not included at the respective location.

Table 1
Summary of Forage Yields
White Oak Mt., 1971 - 1973

SPECIES	YEAR	Soil Amendment Treatments lbs/ac (dry matter) 1	2	3	4	5	6	7
Bromegrass	1971	5410	5481	6004	4778	3666	4921	4743
	1972	3495	3905	3512	3737	3254	4019	3711
	1973	5553	6288	5667	5670	4917	5832	5114
	3-yr. total tons/acre	7.23	7.84	7.59	7.09	5.92	7.39	6.78
Mixed Hay	1971							
	1972	3181	3101	3643	2681	2476	2206	2719
	1973	7622	7542	6191	6969	6431	6448	6499
	3-yr total tons/acre	5.40	5.32	4.92	4.83	4.45	4.33	4.61
Orchardgrass	1971	5730	6239	5943	5495	4979	5855	4985
	1972	3107	3398	2965	2625	2925	2907	3249
	1973	7314	6339	5678	5644	6623	4960	6088
	3-yr. total tons/acre	8.08	7.99	7.29	6.88	7.26	6.86	7.16
Ky 31 Fescue	1971	7538	7721	7491	7103	5733	7701	7171
	1972	5467	5325	5154	5362	5075	4874	4908
	1973	8090	8072	6476	6593	6495	7303	6858
	3-yr. total tons/acre	10.55	10.56	9.56	9.53	8.65	9.94	9.47
Timothy	1971							
	1972	5165	5153	4532	5541	4451	5387	4686
	1973	9486	8335	7001	7542	6614	7611	7405
	3-yr. total tons/acre	7.33	6.74	5.77	6.54	5.53	6.50	6.05
Ladino-Orchard	1971	2996	3174	3466	2908	1880	2805	1880
	1972	3198	3477	2628	2613	2420	2719	2377
	1973	6117	6556	4401	4186	4729	4019	4823
	3-yr. total tons/acre	6.16	6.60	5.25	4.85	4.51	4.77	4.54
Avg. pH-March 1971		4.01	4.12	5.00	3.95	3.93	4.09	3.98
Avg. pH-Sept. 1973		5.48	5.50	5.80	5.35	5.22	5.35	5.15

1 = Rock phosphate
2 = Rock + 200#/ac K_2O
3 = Lime + 160#/ac P_2O_5
4 = P_2O_5 - 46%
5 = P_2O_5 + 200#/ac. K_2O
6 = 2#/ac. Mo + 160#/ac P_2O_5
7 = 2#/ac. Mo + 200#/ac. K_2O

SOME OF THE FORAGE AND TURF RESEARCH AT TIFTON, GA. THAT HAS HELPED TO FEED MAN AND PROTECT AND ENHANCE THE ENVIRONMENT

Glenn W. Burton

Plant Management

1. Bred 20 improved pasture and forage grasses such as Coastal and Midland bermudagrass and Gahi-1 pearl millet.

2. Developed new methods for producing F_1 forage grass hybrids on a commercial scale -- Gahi-1,pearl millet, Tifhi 1 and 2, Pensacola bahiagrass.

3. Discovered how to break and manipulate apomixis in breeding superior bahiagrasses.

4. Demonstrated how the heritable short day sensitivity will extend the grazing season and improve the quality and ease of management of pearl millet.

5. Discovered and developed cytoplasmic male sterility in pearl millet to faciliate production of both forage and grain hybrids, the latter yielding nearly twice as much as open pollinated varieties.

6. Developed tall and dwarf isogenic lines of millet and used them to prove that dwarfing pearl millet will improve forage quality and animal performance to more than offset the reduction in dry matter yield.

7. Studied the inheritance of forage quality (IVDMD) and bred Coastcross-1 that is 12% more digestible and gives 30 to 35% better ADGs and LWGs/A.

8. Showed that IVDMD is heritable and can be improved in pearl millet by breeding.

9. Increased Pensacola bahiagrass forage yields more than 15% by our new recurrent, restricted phenotypic selection breeding technique.

10. Discovered that sterile triploid turf bermudagrass hybrids can be improved by using gamma radiation to create mutations.

11. Removed the bitter alkaloid from blue lupine and added disease and cold resistance to make a promising late-winter, early-spring grazing crop.

12. Collected winter hardy bermudagrasses in Europe and discovered how this characteristic can be combined with IVDMD in improved hybrids.

13. Proved that the cuticle on grass leaves, stems, etc. is the main barrier to rapid digestion and high ADGs of animals fed forage without concentrate.

14. Confirmed that removing the bloom in sorghum increases digestibility of fresh leaves. We are currently breeding a bloomless sorghum-sudangrass forage hybrid.

15. Increased yields, hastened spring growth, controlled spittlebug, reduced incidence of disease and destroyed winter annual weeds.

16. Developed methods of vegetative planting of bermudagrass.

17. Discovered how to lime and fertilize for efficient production.

18. Determined maximum and optimum yields of beef, milk, hay, pellets, protein, carotene, and xanthophyll from Coastal bermudagrass.

19. Developed a nylon bag technique to measure digestibility of small forage samples. Modified IVDMD to analyze up to 10,000 samples/year.

20. Demonstrated the effect of cutting interval on forage quality and animal performance.

<u>Soil Management</u>

1. Developed improved perennial grass varieties that have increased farm profits as they have protected the soil from erosion.

2. Discovered that deep rooted, drought resistant grasses like Coastal bermudagrass properly managed will convert "worthless" sand ridge soils into productive acres.

<u>Water Management</u>

1. Determined the drainage requirements for a number of economically important forages.

2. Found that deep rooted, drought resistant grasses like Coastal bermudagrass will produce as much forage in the Southeast without irrigation as with it in most years.

<u>Environmental Quality</u>

1. Bred five superior bermudagrasses for turf (lawns, golf, parks, football fields, etc.) and developed methods for planting, maintenance, etc.

Good place [illegible] ask for [illegible] on [illegible]

2. Discovered the environmental and maintenance requirements to successfully grow most southern turf grasses.

3. Developed a system of producing 950 lb. steers in 18 months without concentrates and feed lots, using only grazed forages with a very little hay.

4. Bred good sod farming grasses that have kept our streams clear as they have protected the soil from erosion.

RESEARCH IN THE SOUTHEAST WATERSHED LABORATORY

W. G. Knisel, Jr.

The Southeast Watershed Laboratory with headquarters at Athens, Georgia has technical responsibility for hydrologic research in the Coastal Plain and Coastal Flatwoods of the southeast with research watersheds in Georgia, Florida, and North Carolina. The principal study area is the 125 sq. mi. Little River Watershed at Tifton, Georgia. The first instrumentation in Little River began in 1967 and was completed in 1972. In North Carolina, the Ahoskie Creek Watershed, an area of 57 sq. mi., was a cooperative project with SCS and others. The data collection was begun in 1964 and was terminated in 1973. In Florida, three research areas were located at Vero Beach, Stuart, and Okeechobee, Florida. The work was begun at Vero Beach in 1951 and was terminated in 1973. The watershed at Stuart was started in 1961 and terminated in 1973. In Taylor Creek at Okeechobee, research on a 98 sq. mi. watershed was started in 1956 and is being maintained at a reduced level, primarily through cooperation with the Central and Southern Florida Flood Control District.

In North Carolina, the objective was to determine the effects of channel improvement on groundwater recharge and water yield. Unfortunately, the study began after channel improvement and there was minimal data before treatment. A comprehensive analysis and

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Presented by Walter G. Knisel, Jr., Laboratory Chief, Southeast Watershed Laboratory, ARS-Southern Region, Athens, Georgia, at the ARS-SCS Workshop, April 16-18, 1974.

report is being finalized on the study. Several methodologies have been developed, not all of which are directed towards the effects of channel improvement. The results show that in flow duration the high flows have been reduced and low flows have been increased. Total streamflow has increased since channel improvement. However, groundwater observations since channel improvement have shown that the aquifers are recharged to capacity each year and remain fully recharged until early summer. Some of the analytical methods developed include several parametric modeling techniques. A 5-day water yield model has been developed and tested. A streamflow recession model was developed and is now being applied to groundwater recessions. A storm hydrograph model has been developed to derive unit response functions for as many as 10 storms simultaneously. The modeling efforts have recently been directed towards a parametric groundwater model. This is the first real effort in developing groundwater response models, and it is closely tied to the water yield model.

The methodologies being developed in North Carolina will be utilized in similar analyses for Taylor Creek in Florida. Florida data are being organized and assembled for analyses as soon as the North Carolina effort is completed.

In Little River Watershed, little analytical work has been done. The main efforts have been concentrated on characterization of subsurface flow as a part of the total streamflow and as contribution to ponds and pits for on-farm irrigation water supply. Water

balance studies are being made on ponds research data to determine subsurface inflow. Hydrogeologic characterization of the contributing areas is being made. In the Coastal Plain at Tifton, the average annual rainfall is about 50 inches. Of that 50 inches about 30%, or 15 inches, appears as streamflow, and about 80% of the streamflow, or 12 inches a year, has been subsurface flow somewhere along the route. This can have a significant implication in water quality for highly mobile chemicals.

A water quality survey in Little River and surrounding areas showed less total nitrogen, total phosphorus, chlorides, and COD from agricultural watersheds than from urban watersheds.

A significant effort in the SEWL has been in the recent development of a nonlinear least squares method of fitting distribution functions. The usual problems of plotting positions, empty classes, and outliers just disappear in the method. The method has been applied to maximum daily rainfall, peak rates of streamflow, and other hydrologic variates. The log normal probability density function has been applied to monthly maximum rainfall and streamflow data with seasonally continuous transform functions fit over 12 months simultaneously. This provides utilization of monthly values of the variates as opposed to the annual values normally used; i.e., the method is being used to develop time distribution of storm rainfall for 24-hour durations.

Jim Box has already mentioned the cooperative efforts of the groups at Athens and Watkinsville in development of a parametric model for field size areas in the Piedmont to predict water, sediment, and chemical runoff. I won't go into this.

There have been cooperative efforts between the SEWL and the Sedimentation Lab at Oxford, Mississippi, toward development of joint hydrograph and sedigraph models. The models contain a watershed characteristic function--a characteristic of the watershed to produce streamflow and a characteristic of the watershed to produce sediment. The work is at a point of field mapping of the characteristic functions.

Next month a group of ARS people from Oxford, Tifton, and Athens, and a group from SCS at Fort Worth and Athens will be making a field trip and planning session at Tifton. We will be combining our collective talents to consider field techniques for mapping the characteristic functions, and, if possible, sediment and chemical transport data collection programs in Little River. We feel that cooperative efforts are needed to develop the best plans for future research programs to attain the most benefit from our research. This will bring the researchers together in the field with personnel from the action agency to get a first hand look at the problems and plan research to get answers for those problems.

SOIL AND WATER CONSERVATION RESEARCH

SOUTHERN PIEDMONT CONSERVATION RESEARCH CENTER
Watkinsville, Georgia

James E. Box, Jr.

Plant-Soil-Water Relations:

1. Developed infiltration model for Cecil soil in the Southern Piedmont

2. Studying plant-soil-water relations and photosynthesis of peanuts.

Soil Chemistry:

1. Studying the effect of grassed waterway on 2-4-D attenuation in runoff.

2. Evaluating plant nutrient loss from agricultural watersheds.

Plant Management:

1. Showed the effect of crown vetch age on its nutritive value for livestock.

2. Showed the effect of age, clipping height, and leaf, blade, and sheath nutritive value for livestock of coastal Bermudagrass.

3. Demonstrated the effects of pasture fertilization with chicken manure on beef cow health (fat necrosis, grass tetany, parasites, and nitrate poisioning).

4. Showed that spraying fescue pastures with magnesium oxide-bentonite slurry alleviated grass tetany.

Environmental Influence:

1. Presented studies relating to loss of pesticide from agricultural lands. (Treflan, Diquat, and Paraquat)

2. Discussed a modeling effort for predicting loss of agricultural chemicals from agricultural lands.

3. Evaluating the pollution of runoff and ground water resulting from the application of high rates of chicken manure and nitrogen fertilizers on coastal Bermudagrass.

Presented by James E. Box, Jr., Laboratory Director, Southern Piedmont Conservation Research Center, ARS, Watkinsville, Ga., at the ARS-SCS Workshop, April 16-18, 1974.

Soil Management:

1. Presented results indicating that 150 bushel corn yield could be obtained when growing corn in viable fescue sod with irrigation and fertilization.

2. Showed that forage sorghum can be grown in fescue sod without irrigation, and that fescue and forage sorghum yield can be manipulated by killing various percentages of the fescue sod with a contact herbicide.

SCS - ARS Workshop
Ft. Worth, Texas

April 16 - 18, 1974

Research in the Florida/Antilles Area relevant to the SCS-ARS Workshop.

Soil and Water Unit
Gainesville and Ft. Pierce, Florida.
L.H. Allen, Jr., Research Leader, J.S. Rogers, and E.H. Stewart

Research centers on drainage requirements for crops in Florida Flatwoods soils. About 9 million acres are potentially available for cropping if good water management practices can be developed and maintained.

Specific studies include:

1. Three tillage, two drain design and twelve rootstock-scion combinations on citrus production at Ft. Pierce, Florida.

2. Drainage systems for vegetables in mineral soils at Hastings, Florida.

3. Drainage systems for vegetables on muck soils at Zellwood, Florida (near Lake Apopka).

ARS scientist are cooperating with University of Florida scientists in determining outflow of nutrients and pesticides from the citrus drainage system.

Other research centers on runoff and stream flow from the Taylor Creek watershed north of Lake Okeechobee, Florida. This work is closely coordinated with the Southeast Watershed Research Center at Athens, Georgia.

Aquatic Weed Control Unit
Ft. Lauderdale, Florida
R.D. Blackburn, Research Leader, D.B. Perkins, and K.K. Steward

Research Centers on Biological, Mechanical, Chemical, and Water-level manipulation methods, or combinations of methods, on Aquatic weed control. The research is coordinated with the University of Florida.

Research programs involve studies of the use of biological agents on aquatic weed control. These have included various insects, and a grass carp (white amur).

Some problems in chemical weed control lie in obtaining firm tolerances of materials from the EPA in aquatic systems.

Plant Sciences Unit
Gainesville, Florida
M.H. Gaskins, Research Leader

Serves as ARS member on a state Plant Materials Committee, thereby providing ARS liason with SCS.

Presented by L. H. Allen, Jr., Research Leader, Soil and Water Unit, ARS Southern Region, Gainesville, Florida, at the ARS-SCS Workshop, April 16-18, 1974.

Outline of Material Presented

at SCS-ARS Workshop at Ft. Worth - April 16-18, 1974

J. S. Rogers

The effect of three tillage treatments -- surface tillage, deep mixing to 107-cm depth, and deep mixing to 107-cm depth after adding 54 mt/ha of line -- and two drain outlet designs, open and submerged -- on drain clogging and on the response of 6 rootstocks and 2 scions of citrus is being studied on a 50-acre experimental site near Ft. Pierce, Florida.

Drain outflow following heavy rains (Table 1) is significantly higher from the surface tilled treatment (ST) than from the deep-tilled (DT) and the deep tilled plus heavy lime (DTL) treatment. This is contrary to the data from a resistance analog simulation that predicted a slightly higher outflow from DT and DTL than from ST treatments. Hydraulic gradients measured near the drains in DT and DTL treatments (Fig. 2) reveal a zone of lower hydraulic conductivity 5 to 10 cm distal from drain edge. This area included the interface between the gravel envelope and the soil. In the ST treatments (Fig. 3) the zone of lower hydraulic conductivity did not appear. The contradiction in outflow data plus the zone of reduced hydraulic conductivity is evidence for clogging of drains in the DT and DTL treatments.

Water table drawdown (Fig. 1) is slightly faster in the ST than DT and DTL, but because of variability in the data the differences are not statistically significant.

Nutrient content was significantly higher in drain outflow from ST than DT and DTL treatments (see manuscript by D. V. Calvert for details).

Surface runoff is higher from DT and DTL treatments than from ST treatment.

Although deep tillage has hindered drainage, tree growth has been significantly improved.

We are just getting some work underway involving drainage and subsurface irrigation for potatoes. No data are available at this time.

The following manuscripts are attached:

1. SYMPOSIUM: The SWAP Project in Florida. Soil and Crop Science Soc. of Fla. Proc., Vol. 31, Dec. 1971 (contains 11 papers related to SWAP program)

2. Rogers, J. S. and E. H. Stewart. Water Table Behavior During 1972 at the Ft. Pierce SWAP Site. Soil and Crop Science Soc. Fla. Proc. 32:105-107, 1972.

3. Rogers, J. S. and E. H. Stewart. Hydraulic Gradients Near Drains in Modified Soil Profiles. Soil and Crop Science Soc. Fla. Proc. 33:(in press)

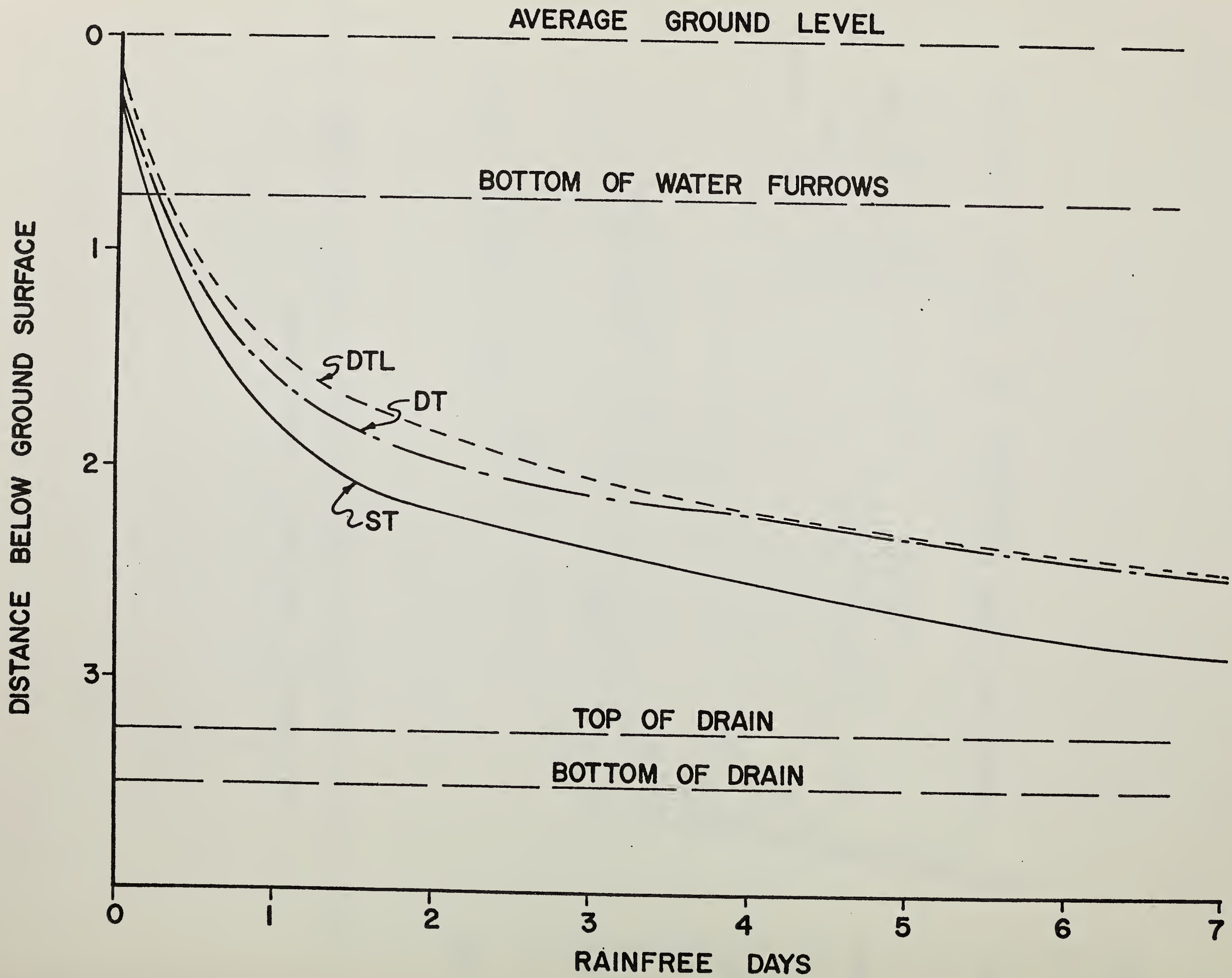
4. Calvert, D. V. Nitrate, Phosphate, and Potassium Movement into Drainage Lines Under Varying Soil Management Systems. (in preparation)

TABLE 1

Drain Outflow June, 1972
Inches Of Water On Plot

	O	S	Avg.	-DTL	-DT
ST	12.60	12.87	12.74	7.40	6.11
DT	7.20	6.06	6.63	1.29	
DTL	5.94	4.74	5.34		
Avg	8.58	7.89			

Tukey's D = 3.67


AVERAGE GROUND LEVEL
BOTTOM OF WATER FURROWS
DTL
DT
ST
TOP OF DRAIN
BOTTOM OF DRAIN
DISTANCE BELOW GROUND SURFACE
0
1
2
3
0
1
2
3
4
5
6
7
RAINFREE DAYS

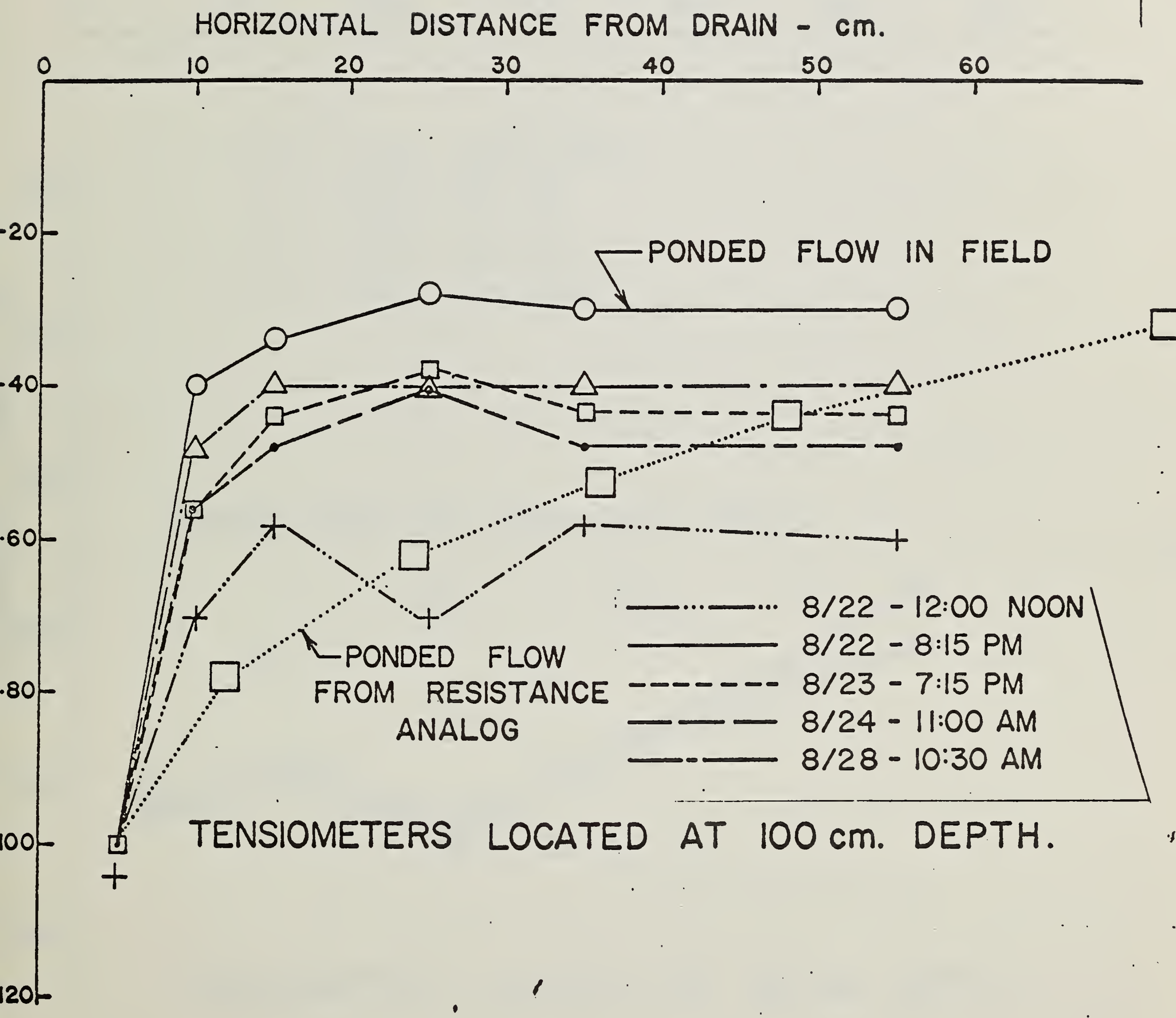
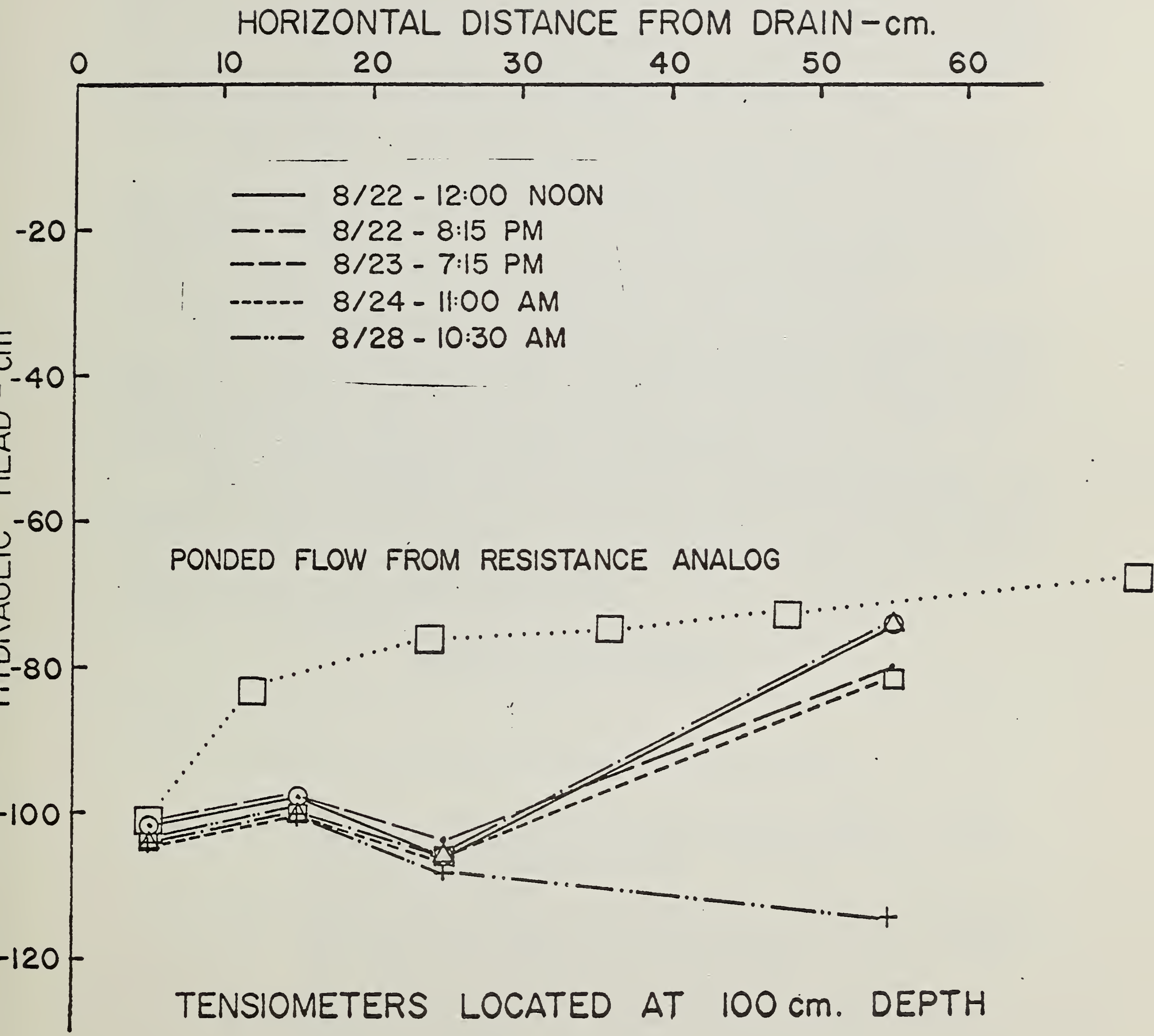

HORIZONTAL DISTANCE FROM DRAIN - cm.
0
10
20
30
40
50
60
-20
-40
-60
-80
-100
-120
PONDED FLOW IN FIELD
PONDED FLOW FROM RESISTANCE ANALOG
8/22 - 12:00 NOON
8/22 - 8:15 PM
8/23 - 7:15 PM
8/24 - 11:00 AM
8/28 - 10:30 AM
TENSIOMETERS LOCATED AT 100 cm. DEPTH.

Figure 2



HORIZONTAL DISTANCE FROM DRAIN-cm.
0
10
20
30
40
50
60
8/22 - 12:00 NOON
8/22 - 8:15 PM
8/23 - 7:15 PM
8/24 - 11:00 AM
8/28 - 10:30 AM
-20
-40
-60
-80
-100
-120
PONDED FLOW FROM RESISTANCE ANALOG
TENSIOMETERS LOCATED AT 100 cm. DEPTH

Figure 3

Aquatic Weed Research

The Aquatic Plant Management Laboratory located at Fort Lauderdale, Florida is concerned primarily with biological and chemical control of aquatic plants, the effects of control procedures on the aquatic environment, and the physiological and ecological factors influencing the growth of the various aquatic plants. Experiments are conducted in the laboratory, greenhouse, growth pools, and in field sites to determine refinements in the most effective and safest techniques of utilizing various control methods alone and in combination for control of aquatic plants.

Biological agents are evaluated in the laboratory, in growth pools, and in small ponds at Fort Lauderdale. Field experiments with insects are conducted at various locations throughout the State of Florida and assistance is supplied to various other state and federal agencies in the southeastern United States that are interested in introduction of the insects. Field experiments with the white amur are conducted in a 150-acre natural lake (Clear Lake) on the west coast of Florida.

Laboratory and growth pool experiments are conducted at Fort Lauderdale with new herbicides and herbicidal formulations to determine their toxicity to various aquatic plants. Herbicides and herbicidal formulations found to be effective are evaluated in field plots. Techniques of applying the herbicide to the aquatic environment to reduce cost, toxicity and increase length of control are evaluated.

Certain environmental factors such as pH, inorganic nutrients, water hardness, and light penetration appear to be related to establishment of aquatic plants in a body of water. Experiments are established in laboratory, greenhouse, growth pool, lakes, and canals to relate these environmental factors to the rapid establishment of exotic submersed aquatic plants in the southeastern United States.

Present Research Efforts

Biological Control of Aquatic Weeds

A. Insects for biological control of waterhyacinth.

(1) Introduce and distribute various insect species; select release sites that will not be disturbed, easily accessible, and large enough to allow the insect population to increase and spread.
(2) Monitor the insect release sites by counting the insects, evaluate plant damage, and the influence of the insects on the aquatic environment. A photographic record is made of conditions at each release site every 3 months.
(3) Studies are conducted on the biology of each released species in light, temperature, and humidity controlled experiments in the laboratory.

Presented by Robert D. Blackburn, Location Leader, ARS, Southern Region, Fort Lauderdale, Florida, at the ARS-SCS Workshop, April 16-18, 1974.

B. Determine the effect of herbicides on the aquatic environment.

(1) Determine the effects of the fish on the ecology of a natural lake in Florida and develop procedures for managing the fish in a large lake.
(2) Develop laboratory procedures for spawning the white amur.
(3) Evaluate the consumption of aquatic vegetation and its efficiency in converting this to body weight.

Chemical Control of Aquatic Plants

A. Evaluate herbicides for control of aquatic plants.

(1) Conduct primary and secondary screening of potential aquatic herbicides in laboratory, greenhouse, growth pools, and field plots.
(2) Develop formulation procedures for aquatic herbicide and determine their effects on control, release rate, and residue.
(3) Study granular formulations of persistent herbicides as a means of reducing regrowth of hydrilla.
(4) Develop proper application equipment for applying aquatic herbicides and evaluate its effect on control and residue levels in soil and water.

B. Determine the effect of herbicides on the aquatic environment.

(1) Residue levels of herbicides in water, soil, plants, and fish.
(2) Determine the effect of aquatic herbicides on the total aquatic environment.

Integrated Control of Aquatic Plants

A. Study the effect of combining insects and herbicides as a control for waterhyacinth.

B. Determine the feasibility of integrating herbicides and the white amur as a control for submersed aquatic plants.

Determine the Environmental Factors Affecting the Growth and Spread of Submersed Aquatic Plants.

A. Study the effect of increased environmental levels of inorganic nutrients on aquatic plants and the uptake of these nutrients by various species.

B. Study production of aquatic plants as related to the various environmental factors influencing a body of water.

C. Study the reproduction processes of hydrilla and the environmental factors that may influence reproduction.

Summary of Research in 19[illegible]

Biological Control with Insects

Populations increased in six of the original eight release sites of the mottled waterhyacinth weevil Neochetina eichhorniae, resulting in decrease in plant size and abundance. A maximum of 200 adult weevils/sq m was found in one site. An additional 45 release sites have been established during the year. Studies to find a method for mass collecting N. eichhorniae for inundative release showed berlese funnels more effective than light traps. Feeding rate, oviposition, and longevity of adult N. eichhorniae were studied at temperatures of 70 and 85° F. Results indicate greater feeding at the higher temperature, no oviposition difference, and greater longevity at the lower temperature. Reports were prepared requesting clearance for introduction of the weevil, Neochetina bruchi in the field and the moth, Acigona infusella, into quarantine. Clearance for N. bruchi is pending, and A. infusella has been cleared for quarantine testing.

Biological Control with Fish

A study in small ponds with the herbivorous white amur Ctenopharyngodon idella fish for aquatic weed control showed that stocking rates will depend on the interrelationship of the amount of vegetation, type of vegetation, and fish size rather than a specific number per unit area. Production of other fish was increased in ponds that were stocked with sufficient white amur to control aquatic weeds. The white amur exhibited a preference for hydrilla (Hydrilla verticillata) while feeding little on vallisneria (Vallisneria americana). The fish grew at an average rate of 8-10 pounds per year.

Uptake of Nutrients by Aquatic Plants

Experimental investigations were conducted in situ on isolated plots in the Everglades marshes to assess the capability of the system for renovating wastewater. Artificial enrichment of sawgrass did not produce increased growth even though nutrients were assimilated into the plants; thus, growth was not limited. Weekly applications of 2.2 kg/ha of phosphorus produced a fivefold increase in tissue levels after 22 weeks. However, this increase represented only 12% of the amount applied. Of the amount which remained, 3% was utilized to produce large increases in algal cells, 5% remained in the water, and 43% settled to the bottom as detritus. Dense algal blooms were maintained over the experimental period and several floral components of the system were eliminated. The marsh system appears to have a limited capacity for assimilating nutrients. Because of this low capacity for nutrient absorption, it is unlikely that sawgrass plants could be used to efficiently renovate wastewater with high nutrient concentrations.

Chemical Control of Aquatic Plants

The method of placing a herbicide in the aquatic environment determines the concentration needed for control. Equipment has been designed to apply herbicides near the bottom of a lake or canal. Bottom application equipment has also been combined with equipment to apply the herbicide as an invert emulsion in flowing water. The combination of proper application

technique and formulation has reduced the concentration of herbicide needed for control and the toxicity to the aquatic environment.

Glyphosate (N-(phosphononethyl) glycine) has exhibited excellent activity on several species of aquatic plants. Spray volumes and plant maturity appear to influence herbicidal activity.

Robert D. Blackburn, Botanist and
Location Leader
B. David Perkins, Research Entomologist
Kerry K. Steward, Plant Physiologist
David Sutton, Assistant Agronomist,
University of Florida

SOIL AND WATER RESEARCH

Auburn, Alabama

Zane F. Lund, Acting Research Leader

This Project was established in the 1950's with a primary mission to evaluate and alleviate soils problems that contribute to water stress in plants during short drouth periods in the growing season.

Most row crop land is sandy, has low water-holding capacity and low organic matter content. It is very subject to compaction, and subsoils are frequently very acid due to leaching of bases and the heavy use of nitrogenous fertilizers. Subsoil acidity, with its associated toxicity factor, aluminum, has greatly affected rooting depth, and has thus received the most effort from this Project. This has not been a straightforward relationship, because a pH of 5.1 in some soils will allow good root growth, and in other soils will completely stop root growth. Exchangeable aluminum determinations in soil show that in some cases 1/2 ppm will completely stop cotton root growth; in other cases 1/2 ppm will have no effect on root growth. It was only after correlation of activity level of aluminum with the amount of other ions or activity of other ions in the soil solution that it was possible to interpolate aluminum toxicity across soils. Not only did soils react differently to aluminum toxicity, but also plant species and even varieties within species. Cotton root growth is very sensitive; soybeans and corn are intermediately tolerant; and peanuts are very tolerant.

Root response, as measured in growth chamber studies, is not always highly correlated with yield. In the intermediate range of pH, around 5.4 or slightly lower, root growth is restricted but yield is not decreased. Severe limitation of root growth, as with a pH of 5.0 in the subsoil, also severely limits yield.

After assessing the effects of pH, the next problem was how to correct them. This resolved into questions: If you incorporate lime from the surface, how deeply must you incorporate to provide sufficient root development to withstand the short periods of drouth? If you are incorporating lime into the subsoil, how thoroughly must it be done to allow satisfactory root growth? Five treatments were set up in the rhizotron bays: (1) subsoil of pH 4.6, (2) subsoil of pH 5.1, (3) subsoil of pH 6.0, (4) alternate layers of 1 inch of pH 4.6 subsoil and two inches of pH 6.0 subsoil, resulting in subsoil being 2/3 neutralized, and (5) alternate layers of 1 inch of pH 6.0 and 2 inches of pH 4.6 subsoil, resulting in subsoil being 1/3 neutralized. Root growth of cotton grown in the pH 4.6 treatment was severely limited; in the pH 5.1 treatment, reduced; and in the pH 6.0 treatment, good. Root growth in the treatment with alternating layers was proportionate to the amount of soil neutralized. Although we do not think of corn as being very susceptible to aluminum toxicity, there is a drastic reduction in root development as the roots grow from a limed surface soil into a pH 4.6 subsoil. When corn was grown in the five treatments, the results were similar to those of cotton, except that the corn developed much better root systems.

Compaction, too, is a serious problem and our early work dealt with attempts to correct it by precision tillage. We have some work on controlled traffic at present, but the Tillage Lab is doing more in this area. We have also had laboratory and growth chamber studies on root forces and on soil strength-moisture relations. In another study, we are using bahiagrass to open up dense subsoils--this work shows a great deal of promise. In a cotton field planted following bahiagrass sod, we have had large yield increases over continuous cotton. Intermediate yield increases were obtained when we chiseled to 15 inches. Roots on continuous cotton were confined to the top 9 inches, or to the plow layer, but roots grew down to 6 ft where cotton followed bahiagrass. Although we have made many soil analyses, such as bulk density, water holding capacity, nitrogen, and carbon analysis to estimate organic matter content, the only measurable factor that could contribute to the increased rooting has been the number of large pores created by the bahiagrass roots. The effect of increased rooting of cotton following bahiagrass as measured by root counts, moisture withdrawal patterns, and yield data has persisted for several years after turning the bahiagrass sod.

Three and one-half years ago, we started a series of studies on animal waste disposal. We have had rhizotron studies, incorporation studies, and surface application studies. One of the treatments in the rhizotron studies was manure-layered to simulate a plowdown or furrow application treatment. This treatment drastically reduced root growth. We feel that this was due to anaerobic conditions set up when a profile is chopped in two, as was done in this case. When this layer decomposed, root growth into the subsoil was excellent.

Another factor in animal waste work that was illustrated rather vividly in the rhizotron was the difference in early growth due to temperature. How much of this temperature change was due to heat of decomposition and how much of it was due to higher absorption rate by darker color of the soil from manure addition, we do not know, but large differences in early growth were evident, and temperature differences of 4 to 6 degrees were measured between treatments. The incorporated treatments were superior in this respect.

We had field plots evaluating manure application rates up to 120 tons per acre. The plots were double-cropped, using millet as a summer crop and rye as a winter crop. The manure application resulted in large millet yield increases over a well-fertilized mineral check. Rye yield increases were not quite as great. We encountered a problem on the first application of loss of germination and early growth of the millet. We felt that this was due to ammonia released by the heavy applications of manure.

We were concerned about forage quality with these high rates of manure application, and most of our rates led to potassium to calcium plus magnesium ratios that would be considered detrimental to animal health. Our nitrate problem was not as great as we had anticipated, but several treatments did exceed the tolerance level for ruminant animals.

Another concern was the effects on soil of heavy application rates of manure. Soil pH was extremely high right after application of the manure,

but dropped as the growing season progressed. The second application did not raise pH sufficiently to allow production of free ammonia, and there were no ammonia problems the second or third years--possibly due to the buffering action of the residue of previous applications. There was an accumulation of nitrogen in the surface soil even at the lowest application rate of manure. We were very surprised at the depth at which some of our reactions were taking place. There was a tremendous increase in potassium down to a depth of 4 ft after two manure applications. When we made our last potassium analysis this bulge had moved down about another 6 inches in depth over the past year, and had increased another 100 ppm, due to the third application. There was a very large pH response to manure application, with pH's increasing over a unit down to a depth of 4 ft. The pH was also depressed at the 5-ft depth. We considered this to be caused by movement of hydrogen from above. The high levels of potassium in solution kicked the H+ off the exchange and it moved down in the profile ahead of the potassium.

We have also used surface applications of manure. In tests located at Thorsby and Auburn, Alabama, we used two rates of solid and three rates of liquid manure on Coastal bermudagrass sod. Our yield data indicated that we could go to manure application rather than mineral fertilizer for growing Coastal without impairing yield. In most cases yields were better on manure-treated plots than on mineral fertilizer plots. Manure application did not greatly influence nitrogen in plants, however nitrate analysis was a much better indicator of the nitrogen status of the soil than organic nitrogen in the plant. The forage was quite high in nitrate but below levels usually considered toxic to ruminant animals. There are no known cases of toxicity in Coastal bermudagrass. There was a definite relation between the nitrate and organic nitrogen content of plant tissue. Once the organic nitrogen in the plant tissue goes above 2.5%, the nitrate level increases very rapidly. Apparently there is a limit on nitrate reductase activity level, and it can convert all of the nitrogen that is taken up by the plant until concentrations of about 2.5 are reached. The plant then accumulates nitrate instead of organic nitrogen.

Another problem is the effect of application of animal waste on quality of runoff water. Several plots were instrumented for measuring runoff, and the runoff water was analyzed for BOD, COD, nitrate N and ammonia N. This technique was used in two series of experiments. The first had 20 tons per acre incorporated in the surface soil and double cropped with rye and millet. There was no difference between amounts of nitrate N in runoff water from the manure-treated plots and the mineral-fertilized plots. The amount of N was acceptable for water moving into navigable streams. The BOD presented a similar picture. There was no difference between the mineral-fertilized plots and the manure-treated plots. Here again, BOD was well below acceptable limits. In fact, in the 3-year period during which this test was run, the highest BOD value obtained was in the fall of the year after a heavy rain following disking or incorporation of the millet stall.

In the second experiment, we had surface application of 20 tons per acre of manure on Coastal bermudagrass. The nitrate N was much higher in the runoff from the manure plots on this treatment than from the check or incorporated manure plots, but below the tolerance levels set by EPA for water moving into navigable streams. The BOD was also higher than on the mineral-fertilized

plots when the manure was applied to the surface.

We are now proceeding in a somewhat different direction. On the subsoil acidity work we are going into the depth of incorporation studies rather heavily. Another aspect of subsoil acidity that we are studying is the changing pH, other than the influence of aluminum. In some soils we get a yield response in pH range of 5.3 to 5.8--in this range there should not be any aluminum present. In other soils, when pH goes above 7 we get a decrease in yield, and we are not certain of the cause.

We are carrying pressure bomb measurement for moisture and the leaf water diffusive resistance measurements into the field to evaluate moisture stress in the plant as a function of rooting depth. These moisture evaluations will also be correlated with growth.

In the rhizotron we are now using several bays for landfill studies. Preliminary studies indicate that vegetation over landfill greatly reduces the amount of leachate. We may also reduce the BOD in the leachate by changing conformation of the landfill and increasing oxidation.

We are studying oxygen status in soils, particularly under wet winter pasture conditions. We feel that this may be a contributing factor to the decline in stand of clover.

RESEARCH IN TILLAGE AND TRACTION AT THE
NATIONAL TILLAGE MACHINERY LABORATORY

P. O. Box 792
Auburn, Alabama 36830

William R. Gill

The National Tillage Machinery Laboratory has special, large soil bin facilities and equipment to conduct research on the forces required and the performance of full-scale machine components on soil. Studies may be made using moldboard plows, disk plows, sweeps, coulters, wheels, tracks, bulldozer blades, and many items of nonconventional machinery. Studies are frequently made in cooperation with manufacturing concerns, and improved designs are usually incorporated into production models. Information is available concerning the following subjects.

1. Tire design and performance on soil
2. Track design and performance on soil
3. Radial ply tractor tire performance
4. Flotation characteristics of agricultural machinery, including harvesters
5. Forces on tillage tools
6. Action of tillage tools on soil
7. Reduction of soil-sticking by auxiliary means
8. Basic studies in soil-machine relations
9. Action of tillage tools on soil
10. Compaction of soils
11. Control of traffic in agricultural fields

The NTML staff can assist in the development of principles of new types of tillage or traction machines. Small manufacturers who do not have research and development personnel may benefit materially from discussions of proposed new machinery designs. Improved designs will not only reduce development costs and time but also provide better performance. SCS or manufacturers may contact NTML directly on such problems.

Soil compaction by agricultural machinery is increasing soil density, increasing runoff and erosion, restricting plant rooting and crop yields, and requiring additional energy. Conventional systems of crop production do not create and maintain optimum soil conditions for maximum crop yields. Principles of tillage and traffic control are being developed to overcome this shortcoming. While current equipment and procedures are experimental, the principles can be applied to conventional systems with some degree of success.

NOTES FOR:

SCS-ARS WORKSHOP

Fort Worth, Texas

APRIL 1974

USDA SEDIMENTATION LABORATORY
Alabama-North Mississippi Area

P. O. Box 1157
Oxford, Mississippi 38655

J. R. McHenry, Acting Laboratory Director

WRU Number: 7503-15040

WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. Research Activity: Prediction of sediment amounts and sources in watersheds and river basins.

2. Responsible Scientists and Location:

Responsible Scientists: C. K. Mutchler, Hydraulic Engineer
N. L. Coleman, Geologist
L. L. McDowell, Research Soil Scientist

Location: USDA Sedimentation Laboratory
Alabama-North Mississippi Area
ARS-USDA
P. O. Box 1157
Oxford, Mississippi 38655

3. Contribution of WRU to Research Activity Objectives:

The CRIS projects in this WRU are:

a) 7503-15040-001 Source and magnitude of sediment yield from watersheds

b) 7503-15040-002 Sediment transport mechanics

c) 7503-15040-003 Sediment properties that affect agricultural chemical transport and channel stability

The overall objective of developing methods for the prediction of sediment amounts and sources in watersheds and river basins will be attained by accomplishing the following sub-objectives:

(1) Develop methodology and techniques for predicting sediment yield and transport in watersheds and river basins.

(2) Define and evaluate chemical and sediment sources in watersheds.

(3) Determine transport mechanics of agricultural chemicals and sediment in runoff waters.

(4) Determine the influence of the physicochemical properties of soils and sediments on water quality and channel stability.

(5) Develop methods of watershed management for control of upland erosion, valley sedimentation, and channel stabilization.

(6) Develop techniques and methods for sedimentation research using electronics, nuclear materials, and remote sensing.

WRU Number: 7503-15040

4. Changes in Direction of Work from FY 1974 to FY 1975:

a) 7503-15040-001: Research on the evaluation of erosion potential of minimum tillage methods for corn is being initiated. This research is a change in direction from the research on no-till soybean erosion evaluation completed in FY 74 as reported in WRU 7503-15060.

Research will be initiated to determine the influence of specific chemical and mineralogical constituents on soil detachment by rainfall.

Research on the basic mechanics of rill and interrill erosion will be initiated. Field studies on very long and very steep slopes will be started to determine basic effects of slope steepness and slope length on soil erosion.

b) 7503-15040-002: Due to the energy crisis and the readjusting of priorities and capabilities as new scientists entered the Research Unit, marked changes have occurred in the direction of the work on sediment transport mechanics.

1. The model study of hydraulic forces on a sediment particle, authorized under CRIS 7503-15060-001 as of FY 1972, is transferred to CRIS 7503-15040-002 as of FY 1975.

2. The current energy shortage has curtailed the use of the 150-cfs. outdoor flume for sediment transport studies.

3. The study of the motion of sediment through a hydraulic jump, planned for FY 74-75 was never implemented, as the 50-foot flume was more urgently needed for a study on the effect of bed forms on sediment suspension.

c) 7503-15040-003: No changes planned.

5. Specific Objectives for FY 1975:

a) 7503-15040-001:

1. Develop and test computer simulations and mathematical models of sediment yield and verify them using gaged watershed records and land use determinations.

2. Delineate and establish the relative significance of sediment sources to sediment yield from watersheds.

3. Determine the effect of channel dredging on sediment yield and the flow regime in a research watershed.

4. Define the relationship of resistance coefficients, seasonal flow variations, and channel conditions to sediment transport in a natural sand bed channel.

5. Develop methods to measure total sediment load under field conditions.

6. Study the sediment production and hydrology of the flat watersheds (less than one percent slope) in the Mississippi Delta.

7. Determine effects of urbanization on watershed sediment yield and hydrology.

8. Evaluate soil conservation value of minimum tillage for corn silage and grain production.

9. Determine value of various tillage and cotton production techniques for reducing sediment losses from Mississippi Delta soils.

10. Develop basic relationships of rill erosion to rill steepness and flow rate for different soils.

11. Develop research techniques and design equipment for study of soil erosion on very long and very steep slopes.

12. Determine the rainfall detachability of texturally and mineralogically defined soil systems.

b) 7503-15040-002:

1. Study hydraulic forces exerted on streambed particles. (Transfer from 7503-15060-001).

2. Study the effects of bed forms on sediment suspension.

3. Study vertical transfer of mass and momentum in a density stratified flow.

4. Study the influence of turbulence on particle fall velocities.

5. Study the distribution of boundary shear stress in channels.

6. Study the effects of sediment size and distribution on bedload transport.

c) 7503-15040-003:

1. Define the role of sediment in the transport of farm chemicals from an intensively cropped flatland watershed (<1 percent slope) in the Mississippi Delta.

2. Determine the losses of N, P, K, and organic matter from no-till corn as compared with conventional-tillage corn on upland watersheds in north Mississippi.

3. Determine the quantity and forms of P in the runoff and sediments from forested watersheds in north Mississippi.

4. Determine in situ the water quality parameters of dissolved oxygen, temperature, conductivity, pH, and redox potential and relate these to the water-chemistry of impoundments.

5. Develop and evaluate field instrumentation and procedures for (the measurement of) redox potentials of bottom sediments in small impoundments.

6. Investigate the reactivity of amorphous iron and aluminum as related to the stability of cohesive soils and sediments.

6. Plan of Work for FY 1975:

a) 7503-15040-001: Sediment delivery, water yield, and land use data will continue to be collected in the Pigeon Roost watershed, the Mississippi Delta flatland watershed, and Laboratory Creek watershed at Oxford. Research emphasis will be increased on acquiring data suitable to verify watershed sediment models. Work will also be increased on using basic erosion and sediment transport principles to develop models for use in predicting sediment yield from un-gaged watersheds. Changes, natural and man-made, in channel and watershed characteristics will be evaluated to determine their effects on the sediment and flow regime in the watershed. Efforts will be continued to develop a field method of measuring total load using a drop structure and a Parshall flume.

The erosion plots at Holly Springs will be used to develop and evaluate minimum tillage systems for corn used for grain and for silage. The basic mechanics of rill erosion will be studied. Research techniques will be developed and equipment designed for new studies of soil erosion on very long and steep slopes. Experiments will be conducted to determine the role of inorganic amorphous constituents and clay type and their interaction on soil detachment by rainfall using synthetic soil mixtures.

b) 7503-15040-002: Sediment transport. Experiments will be performed using (1) the 40-foot water tunnel to study lift and drag forces on a particle, (2) the 50-foot flume to study sediment suspension, (3) the 20-foot by 2-inch flume to study mixing and diffusion processes, (4) computer simulation and the 100-ft. flume to study turbulence effects on particle suspension and settling, (5) the 60-foot flume to study turbulent variation of shear stress.

c) 7503-15040-003: Research will continue on an 83-acre watershed in continuous cotton in the Mississippi Delta (1) to evaluate the magnitude of pesticide and plant nutrient losses by runoff and erosion under current management practices, and (2) to provide the chemical input data needed, together with hydrologic and sediment measurements to model the transport of these farm chemicals from Delta farmlands. The experimental watershed contains a 3.7-acre impoundment that receives the runoff from the cotton land. Automatic pump samplers installed in conjunction with

measuring flumes will be used to obtain suspended sediment samples of the inflow and outflow of the impoundment. Pesticide analyses will be conducted by the ARS Pesticide Laboratory at Baton Rouge, LA. The Sedimentation Laboratory is responsible for the hydrologic, sediment, and plant nutrient measurements. The particle size distributions and organic matter contents of the suspended sediments will be measured to define the influence of these sediment properties on chemical transport. Chemical trap efficiency of the impoundment will be calculated from inflow-outflow measurements. _In situ_ measurements of the oxidation-reduction potential of the bottom sediments will be made. In addition, periodic _in situ_ measurements of dissolved oxygen, temperature, conductivity, pH, and oxidation-reduction potential will be made in the overlying waters using a submersible water quality analysis system. Water-sediment samples collected at the time of the _in situ_ measurements will be analyzed for NO_3-N, NH_3-N, and P.

Cooperative studies with the Sediment Yield Research Unit will be initiated on experimental plots and small watersheds at the North Mississippi Branch Experiment Station, Holly Springs, MS to determine runoff, soil loss, and plant nutrient losses from no-till corn, compared to conventional tillage.

Cooperative studies with the USDA Forest Hydrology Laboratory in Oxford, MS will be initiated on five forested watersheds to determine runoff, sediment, and phosphorus yields. Runoff will be measured with 3-foot H-flumes, and samples will be collected with a Coshocton sampler. Total, hydrolyzable, and orthophosphorus will be measured in the solution phase, and total, inorganic, and organic phosphorus will be measured in the sediment.

The reactivity of amorphous iron and aluminum will be investigated in laboratory experiments. Characteristics of the amorphous material will be defined by extractions, titrations, and other procedures as required. The results will be utilized in the study of the stability of cohesive materials to erosion by water (WRU 7503-15060).

10. Progress in FY 1974:

a. WRU Summary for Intramural Research:

7503-15040-001: Progress was made on the development of a watershed model, especially on the part requiring Snyder's characteristic function. Verification data were supplied and cooperation given to other researchers involved in watershed modeling.

Flow data were obtained from 7 subwatersheds in Pigeon Roost Creek Watershed, Lab Creek Watershed, and the Mississippi Delta Watershed. Land use surveys were completed for 5 watersheds. Channel erosion from a 3.8-mile reach of dredged channel at the outlet of a 177-sq. mile watershed accounted for 5 percent of the total measured sediment. Bank erosion amounted to 65 percent of this channel contribution. A Parshall flume was equipped to measure total load. Soil loss from a 38.8-acre watershed in the Mississippi Delta farmed to cotton totaled 12.8 tons/acre for a year of high rainfall. Seventy-five percent (9.5 tons/acre) of the annual soil loss occurred during the period March-July when the soil was tilled.

Experiments indicated that interrill erosion is affected much less than rill erosion by changes in slope steepness. Mulch was effective in controlling interrill erosion. Analytical studies showed that the relative susceptibilities of a soil to rill erosion as compared with interrill erosion can greatly affect the influence of slope length and steepness on total erosion from sloping land.

7503-15040-002: Progress toward previously stated objectives (WRU Report and Plan, 1973): Sediment transport similitude relationships for high flows: Use of the large outdoor flume has been curtailed due to the recent energy crisis.

Concentration distribution and the sediment transport continuity in a hydraulic jump: Project temporarily suspended to allow for an alternative study of bed forms and their effect on suspension of sediment.

The effect of suspended sediment on the production, intensity and scale of turbulence in open channels: The new projects on the relation of bed forms and sediment suspension and vertical transfer in density stratified flows are providing the data for evaluating the effect of suspended sediment on turbulence.

Turbulence and diffusion phenomena over various boundary types: The first phase of this work is the study of spacial and temporal turbulent shear distribution over channel boundaries. This project is in the apparatus development stage and is progressing well.

WRU Number: 7503-15040

7503-15040-003: The Mississippi Delta (McWilliams') Watershed soils have been intensively sampled and analyzed for pesticide residues (toxaphene, DDT, DDE, DDD, arsenic, and trifluralin), plant nutrients (nitrogen and phosphorus), organic matter, and clay. The inflow and outflow stations of the impoundment have been fully instrumented with measuring flumes, stage recorders, and automatic pumping samplers for sampling suspended sediments. Intact cores of bottom sediments have been taken on selected ranges in the impoundment to determine pesticide, plant nutrient, organic matter, and clay content profiles. Sediment-water-chemical yields are being obtained on single storm events. Preliminary relationships have been established between sediment transport and the transport of pesticides, N, P, and organic matter that will be useful in predicting the sediment phase transport of agricultural chemicals.

Sediment and nutrient losses from five forested watersheds for the period 3-16-72 through 1-2-73 were low compared with agricultural watersheds. Sediment losses ranged from 0.23 to 28 kg/ha. Losses of solution phase P, NO_3-N and NH_4-N ranged from 0.01-4, 0.24-13, and 6-368 g/ha respectively. There was a net gain of soluble P (P-rainfall minus P-runoff) to the watersheds when runoff was <1 cm. Runoff values greater than 1 cm resulted in a net loss of P from the watersheds. Concentrations of NO_3-N and NH_4-N varied seasonally in the runoff.

Characterization of amorphous iron and aluminum by extraction with 1N KCl has been completed, and titration with $Ca(OH)_2$ is in progress. Extractable iron, manganese, aluminum, and total acidity have been determined. Values range from 0-7 ppm for iron, 0-380 ppm for manganese, 0-3 meq/100 g for aluminum, and 0.02-3.5 meq/100 g for total acidity. In general the total acidity and the percentage of the total acidity due to aluminum are both larger for subsoil samples than for surface samples. Relations between stability of cohesive materials and properties of the amorphous iron and aluminum will be evaluated in WRU 7503-15060 upon completion of the characterizations.

Lowest dissolved oxygen values of 6 ppm were observed during the summer in a Mississippi Delta impoundment when the water temperatures were 31°C, and increased to a high of 12 ppm during the winter as water temperatues decreased to 5°C. The pH of the impoundment did not vary greatly above or below eight. Redox values of the aqueous phase were +375 mv during June and decreased during the summer and early fall to +90 mv. As the impoundment became more aerated during the winter, redox values increased to +185 mv. In situ redox measurements of the bottom sediment profile showed a change from positive values in the overlying aqueous phase to negative values of -500 mv in the sediment phase. The change from positive to negative redox values was quite abrupt occurring at the mud-water interface within an 1.5-cm distance.

WRU Number: 7503-15040

Papers published and in press:

Ahuja, L. R. and M. J. M. Römkens. A similarity during early stages of rain infiltration. Soil Sci. Soc. Amer. Proc. In press.

Bowie, A. J., G. C. Bolton, J. A. Spraberry. Sediment yields related to characteristics of two adjacent watersheds. Proceedings, Sediment Yield Workshop, Oxford, MS (1972). In press.

Dendy, F. E. Traversing-slot runoff samplers for small watersheds. ARS-S-15, Aug. 1973.

Glen, L. F., M. J. M. Römkens and D. W. Nelson. A laboratory rainulator for infiltration and soil detachment studies. Agron. Abstracts 1973.

Meyer, L. D. Good news from the search for better erosion control methods. Construction Digest 46(4):52, 54, 56. 1973.

Mutchler, C. K. and R. A. Young. Soil detachment by raindrops. Proceedings, Sediment Yield Workshop, Oxford, MS (1972). In press.

Ritchie, J. C., J. A. Spraberry and J. R. McHenry. Estimating soil erosion from redistribution of cesium-137 fallout. Soil Sci. Soc. Proceedings. In press.

Römkens, M. J. M. and D. W. Nelson. Phosphorus relationships in runoff from fertilized soils. J. Environ. Qual. 3:10-13. 1974.

Römkens, M. J. M., D. W. Nelson and J. V. Mannering. Effect of iron and aluminum hydrous oxides on rainfall detachability of synthetic soil systems. Agron. Abstracts. 1973.

Wischmeier, W. H. and L. D. Meyer. Soil erodibility on construction areas. Highway Research Board Special Report 135:20-29, 1973.

Willis, J. C., A. J. Bowie and D. A. Parsons. Sediment yield estimate based on floodwater measurements and samples. Proceedings, Miss. Water Resources Conference, 1973, pp 13-29.

Alonso, C. V. Numerical integration of the time-dependent equations of motion for Taylor vortex flow. Computors and Fluids, Vol. 1. p. 301, 1973.

Alonso, C. V. The influence of suspended sediment on the surface reaeration of uniform streams. Completion Report OWRR A-062-MISS, Mississippi Water Resources Research Institute, State College, 50 pp. 1973.

WRU Number: 7503-15040

Blinco, P. H., Mahmood, L. and Simons, D. B. Stochastic structure of the turbulent boundary shear stress. Proc. XVth Congress of IAHR, Istanbul, 1973.

Blinco, P. H. and Simons, D. B. Measurement of instantaneous boundary shear stress. Proc. Hydraulic Division Specialty Conference, ASCE, Bozeman, Mont., 1973.

Blinco, P. H. and Sandborn, V. A. Turbulent measurements near a wall with the split-film sensor. Proc. Third Biennial Symposium on Turbulence in Liquids. Rolla, Mo., 1973.

Blinco, P. H. and Simons, D. B. Characteristics of turbulent boundary shear stress. Jour. of the Engineering Mechanics Div., ASCE, Vol. 100, No. EM2, 1974.

Coleman, N. L., Bolton, G. C. and Bowie, A. J. An attempt to predict channel sediment transport capacity using similitude principles. Proc. Sediment Yield Workshop, Oxford, Miss., ARS Misc. Publication 1054, 1974.

Parr, J. R., G. H. Willis, L. L. McDowell, C. E. Murphree, and S. Smith, An automatic pumping sampler for evaluating the transport of pesticides in suspended sediment. Accepted for publication by J. Environ. Quality, January, 1974.

Papers and presentations requiring formal ARS approval:

Foster, G. R., L. D. Meyer and C. A. Onstad. Erosion equations derived from modeling principles. Presented at ASAE Winter Meeting, Dec. 1973.

Lattinzi, A. R., L. D. Meyer, M. F. Baumgardner. Influence of mulch rate and slope steepness on interrill erosion. Presented by Meyer at ASA Annual Meeting, Las Vegas, Nevada, Nov. 1973.

Meyer, L. D. Erosion control with crushed stone. Annual Convention of Iowa Limestone Producers Assoc., Inc. Feb. 20, 1974.

Meyer, L. D. Prediction of sediment yield from unprotected soils. Minnesota Water Resources Seminar "Control of erosion and sediment from small watersheds", University of Minn. and N. W. Section ASCE. Nov. 20, 1973.

Meyer, L. D. and G. R. Foster. Stage recorders with direct float-to-pen linkage. Presented at ASAE Annual Meeting, Lexington, Kentucky, June 1973. Accepted for publication.

Alonso, C. V. On the structure of separated viscous flows, 10th Anniversary Meeting, Soc. of Engineering Science, North Carolina State U., 1973.

McDowell, L. L. Proposed ASTM procedure for determining suspended sediment concentration. Presented at the American Society for Testing and Materials Committee Meeting on Methods for Fluvial Sediment Analysis, Fort Lauderdale, Fla., January 1974.

McDowell, L. L. Sediment and chemical losses from a Mississippi Delta watershed. Presented at the Sigma Xi Club Meeting, Stoneville, Mississippi, April 1974.

Presentations not requiring formal ARS approval:

Bowie, A. J. Sediment yield investigations in a complex watershed. Presented at SCS State Staff Meeting, Jackson, Mississippi, January 28, 1974.

Meyer, L. D. 1. Soil losses from critical areas, and new practices for erosion control on such areas. 2. Adapting the Universal Soil Loss Equation for the Southeast, and determining terrace spacings. SCS-ARS Workshop, Chickasha, Okla. January 1974.

Mutchler, C. K. 1. Evaluation of R factors 2. Sediment and Water Yields from Pigeon Roost Creek Watershed 3. Urban watershed research. SCS-ARS Workshop, Chickasha, Okla., January 1974.

Murphree, C. E. Runoff and sediment losses from a Mississippi Delta watershed. SCS State Planning Staff Meeting, Jackson, Mississippi, January 21, 1974.

Schreiber, J. D. Phosphorus-Sediment Relationships in a Midwest Reservoir. ARS Phosphorus Workshop, Beltsville, Md., 1973.

McDowell, L. L. Soil and water conservation research needs in Mississippi. Presented at the Annual Meeting of Mississippi Association of Soil and Water Conservation District Commissioners (Committee on Research), Jackson, Mississippi, November 1973.

McDowell, L. L. Critique of report (prepared by ERS) on methods, practices, and procedures for controlling nonpoint sources of agricultural pollution. USDA-Economic Research Service-Environmental Protection Agency Meeting, Athens, GA, July, 1973.

McDowell, L. L. Sediment-water chemical relationships in agricultural runoff, USDA-ARS meeting on Agricultural Chemical Transport Modeling, Athens, GA, January, 1974.

McDowell, L. L. Sediment-phosphorus research in the Southeast, USDA-ARS Phosphorus Workshop, Plant Industry Station, Beltsville, Maryland, 1973.

McDowell, L. L. Sediment and chemical losses from agricultural lands, ARS-SCS Southern Regional Workshop, Chickasha, Oklahoma, January, 1974.

McDowell, L. L. Agricultural chemicals (pesticides and commercial fertilizers) and water quality, SCS Sanitary Engineering Training Course, SCS Regional Technical Service Center, Fort Worth, Texas, November, 1973.

McDowell, L. L. Sediment and chemical yields from Mississippi Delta farmlands, Mississippi SCS Soil Scientist Workshop, Jackson, Mississippi, February, 1974.

McDowell, L. L. Prepared statement for use as USDA potential witness in Environmental Protection Agency-Environmental Defense Fund Hearings on Environmental Impact of Aldrin and Dieldrin, 1974.

b. Summary of progress for Extramural Projects:

No extramural projects were supported during FY 1974.

WRU Number: 7503-15050

WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. Research Activity: Improving Control of Reservoir Sedimentation

2. Responsible Scientists and Location:

Responsible Scientist: J. Roger McHenry, Research Chemist

Location: USDA Sedimentation Laboratory
Alabama-North Mississippi Area
ARS-USDA
P. O. Box 1157
Oxford, Mississippi 38655

3. Contribution of WRU to Research Activity Objectives:

The overall objective of providing new and improved design and operational techniques and guidelines for the storage, control, and management of sediment in reservoirs, as well as reliably estimating quantity, density, distribution and chemical behavior of sediment and successfully achieving the following specific sub-objectives:

(1) Develop criteria for making forecasts, in specific quantitative terms of

(a) Reservoir trap-efficiency,

(b) Vertical and horizontal distribution of sediment within reservoirs,

(c) Volume-weight of reservoir sediment,

(d) Reservoir delta formations and upstream extensions,

(e) Channel degradation below dams.

(2) Provide concepts and feasibility of outlet works and other engineering structures for manipulating volumes of sediment reaching small to medium-size reservoirs.

(3) Define and develop means to control the sediment-water-chemical interrelationships that affect the dissolved and dispersed chemical load in reservoirs.

(4) Provide information on the concentration and rate of accumulation of radioactive fallout in reservoir sediments and associated potential hazards.

(5) Develop criteria for evaluating suspended sediment concentrations from remote sensing.

WRU Number: 7503-15050

4. Changes in Direction of Work from FY 1974 to FY 1975:

   a. Obtain ground truth information from reservoirs to correlate with remote sensing imagery.

   b. Obtain information on heat budget of small reservoirs as influenced by concentration of suspended sediment.

5. Specific Objectives for FY 1975:

   a. (1) To continue studies of the trap efficiencies of selected reservoirs.

      (2) To determine sediment deposition patterns in reservoirs by laboratory model studies.

   b. (1) To calibrate and evaluate a multi-head gamma transmission gage for the measurement of suspended sediment concentrations in reservoirs.

   c. (1) To develop facilities and methods for measuring stratified (density) flows.

      (2) To evaluate field techniques and instruments for measuring reservoir hydrodynamic parameters.

   d. (1) To correlate various chemicals found in sediments with the origin of the sediment.

      (2) To develop and evaluate field methods for measuring redox, chemical content, dissolved oxygen, turbidity, pH, temperature, and reflectance of reservoir waters.

      (3) To evaluate test, design or modify remote sensing techniques for use in sediment research.

6. Plan of Work for FY 1975:

   The research necessary to achieve the above objectives will be carried out in the USDA Sedimentation Laboratory and at such field sites and on such reservoirs as considered necessary, desirable, and accessible. Specifically the following research will be conducted:

   a. Data collection will continue on selected reservoirs which are a part of the on-going field study of sediment trap efficiency. In addition, one or more small structures will be instrumented for study if suitable sites can be found.

b. Measurements of densities of in situ (underwater) sediments will be continued as requested in support of research projects. The evaluation and development of a multi-head nuclear sensor system to measure concentrations of suspended sediments will continue.

c. Nitrogen, carbon, phosphorus and potassium contents of sediments and soils will be measured and analyzed as to origin, pattern of occurrence, and concentration within the sediment profile. Methods of analyses will continue to be evaluated for use in sedimentation research. Studies of heavy metal loading of sediments will continue.

d. Measurements of spectral reflectance will be made from surface craft on four large lakes in north Mississippi, Sardis, Arkabutla, Enid, Grenada. Measurements of water depth, temperature, turbidity, sun angle, pH, and chemical content, vertically and horizontally, will be made at the same time and location. Results will be compared to remote sensing (photographic) imagery obtained from NASA (ERTS-A or high altitude flights). These preliminary findings will be used to plan additional studies if ground truth measurements are adequately reflected in remote sensing imagery.

e. A laboratory data logging system will be assembled and evaluated for use with various data collection studies.

WRU Number: 7503-15050

10. Progress in FY 1974:

a. WRU Summary for Intramural Research:

(1) Data obtained over an extended period on the sediment trap efficiency of a selected group of seventeen floodwater-retarding reservoirs were analyzed and reported. In spite of widely varying reservoir size, shape, and sediment inflow rates and volume, trap efficiencies varied over a relatively small range. With the exception of a pond-type structure much smaller than the others, trap efficiencies ranged from 81 to 98 percent. Trap efficiencies of the dry reservoirs, although generally for shorter record periods, were essentially the same and varied over about the same range as the normally ponded reservoirs. Virtually, all sediment particles, sand size and larger, were trapped in all of the reservoirs.

Studies of sediment deposition patterns in a small gorge-type reservoir model were continued. Utilizing sized sands, tests were conducted to evaluate the effect of water inflow rate, sediment concentration, and sediment particle size on delta development and slope. Initial tests showed a readily definable relationship between the slope of the delta and sediment concentration for a given inflow discharge and sand size. Further tests are scheduled on models of various shapes and configurations to evaluate the effect of reservoir geometry on sediment deposition patterns.

A study of the nutrient content of sediments from selected reservoirs in north Mississippi showed an increase in the contents of N and P in the more recent sediments. The increase in nutrients does not appear to be related to agricultural fertilizer use.

Research was started on the use of remote sensing techniques to measure suspended sediments in reservoirs. A significant (r=0.89) linear relationship was found between total suspended solids and reflected light at 750nm. Present studies indicate that either reflected light or reflectance may be used to estimate total solids in north Mississippi reservoirs.

Preliminary evaluation tests were conducted with the multi-detector nuclear sediment concentration gauge. In order to provide greater sensitivity the gage is being modified. Otherwise, the performance of the system was according to design.

WRU Number: 7503-15050

A regular monitoring program was begun during the second quarter of 1973 in which six reservoirs were studied. These include the 4 large C of E flood control reservoirs; Sardis, Arkabutla, Enid, and Grenada, and two small SCS sediment retention reservoirs; Y-5-121 and Y-5-122 on Dry Fork Creek. An automated weather station was planned and partially constructed at the Sedimentation Laboratory.

Phosphorus analyses of a midwest reservoir showed the total, hydrolyzable, and ortho phosphorus concentrations in the solution phase of the inflow to be twice that of the outflow. The sediment phase of the outflow had a larger concentration (μg/g) of total, inorganic, and organic phosphorus than the inflow sediment; however, the percentages of these three fractions were the same for both sediments. Isotopic dilution techniques utilizing ^{32}P showed the average values for P solid (isotopically exchangeable) and labile P (P solution + P solid) to be .039 and .098 μg/ml for the inflow versus .019 and .051 μ g/ml for the outflow. The quantity of isotopically exchangeable P solid was 114 μg/g for the inflow sediment and 77 μg/g for the outflow sediment, which represents 22 and 13% of the inorganic phosphorus fraction, respectively, for the inflow and outflow sediments.

(2) Publications:

Dendy, F. E., and Champion, W. A. Summary of Reservoir Sediment Deposition Surveys made in the United States Through 1970. USDA Misc. Pub. 1266, 82 pp., July 1973.

Dendy, F. E., Champion, W. A., and Wilson, R. B. Reservoir Sedimentation Surveys in the United States. AGU Monograph Series Vol. 17:349-351, 1973.

McHenry, J. Roger, Hawks, Paul H., and Gill, Angela C. Sediment Control Methods: D. Reservoirs., Discussion of: Jour. Hydraulics Div. Amer. Soc. Civil Engr.; 100: (HY2)332-335, 1974.

McHenry, J. R., Ritchie, J. C., and Gill, A. C. Nitrogen, phosphorus, and other chemicals in sediments from reservoirs in north Mississippi. In Proceedings Mississippi Water Resources Conference 1973, 1-12, Mississippi State: Water Resources Research Institute, 1973.

WRU Number: 7503-15050

McHenry, J. Roger, Ritchie, J. C., and Gill, Angela C. Accumulation of Fallout Cesium 137 in Soils and Sediments in Selected Watersheds. Water Resources Research 9:676-686. 1973.

Ritchie, Carole A., Ritchie, Jerry C., and Plummer, G. L. 1973. Water content of three Fuquay soils supporting two vegetation types. Bulletin of the Georgia Academy of Science. 31(3): 151-160.

Silberman, Edward, Schiebe, Frank R., Mrosla, Edward. 1973. The Use of Standard Bodies to Measure the Cavitation Strength of Water, University of Minnesota, St. Anthony Falls Hydraulic Laboratory, Project Report No. 141.

Papers prepared and approved, but not yet published:

Dendy, F. E. Sediment Trap Efficiency of Small Reservoirs. (Submitted for ARS approval for publication)

McHenry, J. Roger. Reservoir Sedimentation, Water Resources Bulletin (In press)

Silberman, E., and Schiebe, Frank R. A Method for Determining the Relative Cavitation Susceptibility of Water to be published in Proc. of Institution of Mechanical Engineers, Sept., 1974.

Ritchie, Jerry C., McHenry, J. Roger, Schiebe, Frank R., Wilson, Robert B. 1974. The relationship of reflected solar radiation and the concentration of sediment in the surface water of reservoirs. p. . In. F. Shahrokhi (ed), Remote sensing of earth resources, Vol. III. The University of Tennessee Space Institute, Tullahoma, Tennessee.

Technical presentation:

Ritchie, J. C. (Co-authors: McHenry, J. R. and Gill, A. C.) Nitrogen, phosphorus, potassium, and carbon in sediments and soils of some upper midwest watersheds. Presented at the 1974 annual meeting of the Southern Branch of the Agronomy Society of America with the Southern Association of Agricultural Scientists; Memphis, Tennessee, February 5, 1974.

McHenry, J. R. SCS-ARS Workshop, Chickasha, Oklahoma, Jan. 31-Feb. 1, 1974.

(1) Sediment yields from critical areas in relation

to stream pollution and sediment storage capacity design; (2) The identification and measurement of eroded soil materials deposited in reservoirs; (3) Removal of sediment from water flows.

McHenry, J. R. Seminar, Dept. of Agronomy, Mississippi State University, March 4, 1974. "Erosion and sedimentation research at the USDA Sedimentation Laboratory."

McHenry, J. R. (Co-authors: Ritchie, J. C. and Spraberry, J. A.) Estimating soil erosion from the redistribution of fallout ^{137}Cs. Presented before Division 6, Soil Science Society of America, Las Vegas, Nevada, November 13, 1973.

10. b. WRU Summary for Extramural Projects: N/A

c. CRIS Work Unit Progress Report:

WRU Number: 7503-15060

WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. Research Activity: Improving Water Erosion Control and Stream Channel Stabilization.

2. Responsible Scientist and Location:

Responsible Scientist: W. C. Little, Hydraulic Engineer

Location: USDA Sedimentation Laboratory
Alabama-North Mississippi Area
ARS-USDA
P. O. Box 1157
Oxford, Mississippi 38655

3. Contribution of WRU to Research Activity Objectives:

Control of erosion on lands and in stream channels will drastically reduce sedimentation and water pollution problems. Understanding of the basic physical principles and concepts on which the control techniques will be based should result from the following objectives:

(1) Study of the hydraulic forces exerted on individual sediment-like particles on a movable bed surface. Knowledge from this study will be used to mathematically describe the movement and transport of sediment.

(2) Development of methods, procedures and equipment for stream bank and stream bed erosion control. New methods for stabilizing soils from water erosion are being sought. New knowledge on stream channel morphology will be assembled. New designs for bed and bank erosion control structures will be developed based on the hydraulics, geological and soils conditions of individual systems.

(3) Improvement of farm erosion control practices. New farming methods and systems, such as no-till cultivation, have been made possible by chemical weed control. The no-till method has been introduced and now must be economically and physically feasible over a period of time.

4. Changes in Direction of Work from FY 1974 to FY 1975:

Basic research related to item (1) under Section 3 has been transferred to WRU 15040.

Research under item (2) will be expanded and intensified with the addition of new staff (0.5 SMY).

The no-till erosion evaluations has been transferred to WRU 15040.

The only research to be conducted under WRU 15060 at the USDA Sedimentation Laboratory during FY 1975 will be by the Stream Channel Research Group.

5. Specific Objectives for FY 1975:

(1) To study the stability of soil materials for a possible relationship between soil properties and laboratory and field determined stability.

(2) Make model and field studies to develop the design of low-drop structures for erosion control on stream channels.

(3) Conduct a field study of severely eroded stream channel systems to obtain: history of the erosion activity; data to explain the relative contributions and to delineate the sediment production from overland flow, bed degradation and bank erosion; and to develop procedures and methods for alleviating and correcting bed and bank instabilities.

6. Plan of Work for FY 1975:

Possible relations between soil properties and the laboratory determined stability will be evaluated by correlation and regression analyses. Concepts and theories regarding the role of physical, chemical and mineralogical properties of soils and of internal water content and movement involved in cohesive soil stability will be developed and investigated. The relative erodibility of channel bed and bank materials will be determined.

The results of the characterization of the effects of amorphous materials (WRU-7503-15040) will be used to evaluate possible influences of the amorphous phase on previously determined stability of cohesive materials. These influences will also be evaluated by regression techniques. Studies of the stability of cohesive materials will continue using both remolded and undisturbed samples.

A hydraulic model study will be continued to develop generalized criteria for the low drop structures for field channels. The proposed structures are formed from large, graded riprap materials. At the conclusion of the

model study, a field study will be initiated to study and observe the drop structures of differing designs and constructed of different materials.

For the field study of severely eroded stream channel systems, several reaches of a channel have been tentatively selected as experimental sites. The morphology of the stream will be determined from aerial photographs and field surveys. Pertinent geological parameters will be determined from prior studies and additional field measurements. The hydrology of the system will be determined from prior records and newly established gaging stations. The sediment production parameters will also be obtained from past measurements and continuing observations. Field measurements of massive bank failure and relative erodibility at critical locations will give estimates of the forces causing failure under actual field conditions. Laboratory measurements will be made of all pertinent physical-chemical properties of each stratigraphic unit to describe the mechanisms of failure involved.

10. Progress in FY 1974:

The time mean drag coefficient-Reynolds number function has been defined for Reynolds numbers from 0.8 to 10,000. The effect of velocity gradient (circulation) on this function is now being evaluated. Frequency response limitations in velocity measuring equipment are hampering efforts to evaluate instantaneous turbulence effects and to obtain cross-correlation and cross-spectrum functions.

Previous studies have indicated that the (sample) pH in water and the difference between the pH in water and that in 1N KCl were both stability indicators. These values were used as a quick test to reflect gross properties of the sample amorphous phase. Initial results indicate some agreement between the amount of extractable aluminum and the difference between the two pH values. Samples with relatively large differences between the two pH values also exhibit large values for extractable aluminum. Possible relations between stability and extractable aluminum will be evaluated by regression analysis on completion of the amorphous material classification.

A design procedure was developed to determine if an alluvial sand bed would naturally armor. The procedure will determine for a given sediment distribution the maximum flow conditions which can exist and the stream bed still armor. The procedure will also determine both the armor coat size and distribution after armoring has occurred.

Selected reaches of Cuffawa Creek, a severely eroding stream channel have been partially instrumented. Characterizations of the soil physicochemical properties, along with the physical state, of the bank materials is under way. Preliminary analysis of flow depths in Cuffawa Creek for the period 1960-1972 showed that of the total time for which flow was occurring in the stream, the flow depth was 3.0 feet or less 95 percent of the time. Other analyses are in progress.

The evaluation of no-till tillage for soybeans on erosion plots showed a control of soil erosion to 1-ton/acre which is far below most acceptable levels. Determination of the raindrop size-rainfall intensity for northern Mississippi was completed; further analysis is necessary for final definition of the relationship and calculation of an annual rainfall factor.

10. Progress in FY 1974:

a. WRU Summary for Intramural Research:

Publications:

Robinson, A. R. The Problem with Sediment, Proceedings, Georgia Governor's Conference on Sediment Control, p 5-12, July 1973.

Approved but no yet published:

Little, W. C. and P. G. Mayer. Stability of Channel Beds by Armoring, to be published in Journal of Amer. Soc. Civ. Engr., Waterways Harbors and Coastal Engineering. Presented at Annual Water Resources Conference, ASCE, Los Angeles, Calif., January 1974.

WRU Number: 7503-17001

WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. Research Activity: Accumulation of Cesium-137 Fallout in Reservoir Sediments.

2. Responsible Scientist and Location:

Responsible Scientist: J. Roger McHenry, Research Chemist

Location: USDA Sedimentation Laboratory
Alabama-North Mississippi Area
P. O. Box 1157
Oxford, Mississippi 38655

3. Contribution of WRU to Research Activity Objectives:

The overall objective of providing new and improved design and operational techniques and guidelines for management of sediment in reservoirs, as well as stream channels, will be achieved by the successful attainment of the following specific subobjectives:

(1) To measure the levels of radioactivity in sediments from selected lakes, reservoirs, and estuaries.

(2) To compare the levels of measured activity of sediments in lakes, reservoirs, and estuaries with levels found in soils considered to be the source of the given sediment.

(3) To review procedures for sediment sampling and to adopt, adapt, modify, or devise suitable techniques for the sampling of sediments (underwater) for use in radioactivity analyses.

(4) To review procedures for determining radioactive content of sediment samples and to adopt, adapt, modify, or devise suitable techniques and methods.

(5) To relate, using statistical methods and computer techniques, the distribution, vertically and horizontally within a containment basin, of radioactivity to fallout frequency and to the erosional activity of the upstream watershed.

(6) To compute, if possible, travel times of various soil constituents containing radioisotopes from the upland to the depositional area.

4. Changes in Direction of Work from FY 1974 to FY 1975:

Provide information on occurrence and distribution of short-lived gamma emitting radioisotopes in reservoirs, sediments and soils. This work was scheduled for FY 1974 but due to equipment problems it was not initiated.

5. Specific Objectives for FY 1975:

a. To measure the levels of radioactivity in sediments from selected impoundments.

b. To compare the levels of measured radioactivity of sediments from impoundments with those levels found in soils from areas considered the source of the sediment.

c. To relate by statistical methods (using digital computer) the distribution, vertically and horizontally within a containment basin, of the radioactive fallout to the erosional activity of the contributing watershed.

d. To place in operation a 4096-channel analyzer using a germanium solid state detector for detecting accurately short-lived gamma emitting radioisotopes.

6. Plan of Work for FY 1975:

The research designed to achieve the above objectives will be carried out in the laboratory facilities at the USDA Sedimentation Laboratory and at various reservoirs, lakes, estuaries, and watersheds in Mississippi, in the Southern Region, and throughout the county.

The measurement of ^{137}Cs in soils and sediments will continue using the NaI detector and 1024-channel analyzer. The redistribution of ^{137}Cs fallout in a watershed will be measured in an effort to determine the amount of soil erosion and soil movement that has occurred on a watershed. Additional sensitivity of measurement of gamma fallout is anticipated with the 4096-channel pulse height analyzer and solid-state detection system. Measurements of short-lived gamma emitters, as ^{95}Zr-Nb, ^{106}Ru-Rh and ^{131}I, will be possible with this detector. Interpretations of data, based on computer analyses, will be made. No new sampling is scheduled for FY 74-75. If samples of soil, or sediment, are taken they will be for special problems arising from interpretation of previous data.

WRU Number: 7503-17001

10. Progress in FY 1974:

a. Research continued on the use of fallout ^{137}Cs in sediment research. A significant (r = 0.89) logarithmic relationship was found between computed soil erosion, as calculated by the Universal Soil Loss Equation and the cumulative loss of fallout ^{137}Cs under different land use in three north Mississippi watersheds. This indicates that fallout ^{137}Cs may be used to estimate soil erosion.

b. Publications:

(1) McHenry, J. R., Jerry C. Ritchie, and A. C. Gill. 1973. Nitrogen, phosphorus, and other chemicals in sediments from reservoirs in north Mississippi. Proceedings Mississippi Water Reservoirs Conference 1973:1-13.

(2) McHenry, J. Roger, Jerry C. Ritchie, and Angela C. Gill. 1973. Distribution and accumulation of fallout cesium-137 in soils and sediments in selected watersheds. Water Resources Research 9(3):676-686.

(3) Ritchie, Jerry C., and J. Roger McHenry. 1973. Determination of fallout ^{137}Cs and natural gamma-ray emitting radionuclides in sediments. International Journal of Applied Radiation and Isotopes 24(10):575-578.

(4) Ritchie, Jerry C., and J. Roger McHenry. 1973. Vertical distribution of fallout cesium-137 in cultivated soils. Radiation Data and Reports 14(12):727-728.

(5) Ritchie, Jerry C., J. Roger McHenry, and Angela C. Gill. 1973. Dating recent reservoir sediments. Limnology and Oceanography 18(2):254-263.

(6) Ritchie, Jerry C., J. Roger McHenry, Angela C. Gill, and Paul H. Hawks. 1973. Distribution of ^{137}Cs in a small watershed in northern Mississippi. p. 129-132. IN: D. J. Nelson (ed.) Proceedings of the third National Symposium on Radioecology, May 10-12, 1971, Oak Ridge, Tennessee. CONF. 710501-pl.

c. Paper prepared and approved but not yet published:

(1) Ritchie, Jerry C., J. Roger McHenry and Angela C. Gill. 1974. Fallout ^{137}Cs in the soils and sediments of three small watersheds. Ecology 55:

(2) Ritchie, Jerry C., J. A. Spraberry and J. Roger McHenry. 1974. Estimating soil erosion from the redistribution of fallout ^{137}Cs. Soil Science Society of America Proceedings 38(1):

d. Technical Presentations:

(1) McHenry, J. R. Estimating soil erosion from the redistribution of fallout ^{137}Cs. Presented before Division 6, Soil Science Society of America Annual Meeting, Las Vegas, Nevada, Nov. 14, 1973.

(2) Ritchie, Jerry C. The use of fallout ^{137}Cs to determine sediment movement in small watersheds and trap efficiencies of small reservoirs. Paper presented at the 24th Annual Meeting of the AIBS and the Ecological Society of America, Amherst, Massachusetts. June 18, 1973.

(3) Ritchie, Jerry C. Nitrogen and phosphorus in sediments of some southeastern reservoirs. Paper presented at the 34th Annual Meeting of the Association of Southeastern Biologist at Bowling Green, Kentucky. April 13, 1973.

WRU Number: 501-7502-12310

WORK REPORTING UNIT REPORT AND PLAN
FY 1974 - FY 1975

1. Research Activity: Techniques for Efficient Water Use on Nonirrigated Crop and Grasslands.

2. Responsible Scientist and Location:
   Responsible Scientist: Donald L. Myhre, Soil Scientist

   Location: USDA, ARS
   P. O. Drawer DL
   Mississippi State, Mississippi 39762

3. Contribution of WRU to Research Activity Objectives: This WRU contributes to answering the following objectives on pages 11 and 12 in Research Activity 1-34-105-05-030:

   "4a. Availability of soil water for optimum plant growth ----."

   "(1) What is the tolerance of different genotypes to time and duration of drouth --- at critical growth stages?"

   "(3) How can drouth be accurately defined in terms of internal plant stress --- and solar radiation?"

   "(4) To what extent is plant stress for water -- relieved by managing such factors as ------------- soil fertility and seeding time?"

   "(5) How can the availability of water to undesirable plants (-- weeds) be decreased?"

Presented by Donald L. Myhre, Research Soil Scientist, ARS, Southern Region, Plant Science Laboratory, Mississippi State, Mississippi, at the ARS-SCS Workshop, April 16-18, 1974, Fort Worth, Texas.

WRU Number: 501-7502-12310

4. Changes in Direction of Work from FY 1974 to FY 1975:

a. The major research effort will continue to be on conservation tillage and residue management in single soybean crop systems and in soybean-wheat double cropping systems.

b. Exploratory research, until additional funds become available, will involve studies pertaining to identifying constraining and controllable soil factors in order to optimize the soil root environment for maximum N_2-fixation and rate and length of dry matter accumulation in soybean seed.

5. Specific Objectives for FY 1975:

a. In a double-cropping system of soybeans and wheat:

(1) Determine the relationship between soil factors, plant growth, rooting characteristics, and water-use to fertilizer requirements in order to predict more accurately the amount of fertilizer needed and the best time and method of seeding wheat.

(2) Improve cultural practices, including wheat straw residue management, conservation tillage, and weed control for optimal yields, maximum returns to land and management, and minimal soil loss.

b. In a continuous soybean system:

(1) As an alternative practice of chisel plowing and disc hipping of rows in the fall on fine-textured soils, the following hypothesis will be tested: Soybeans can be successfully planted in the previous soybean crop stubble and weeds can be effectively controlled with herbicides and cultivation in the Blackbelt and Delta where Johnsongrass is not a problem. In addition, answers will be obtained for the following questions:

(a) If residues are not plowed under, will insect and disease problems increase?

(b) What will be the long-term effect if residues are left on the soil surface?

WRU Number: 501-7502-12310

6. Plan of Work for FY 1975:

A. Double-cropping system (soybeans and wheat and/or sorghum/wheat):

1. Brooksville, Mississippi (Blackbelt Station)

a. Experiment No. 1. Rates of N for wheat following soybeans or grain sorghum. This research will develop insight on the nitrogen budget in the double-cropping system, the nitrogen contribution of soybeans to the succeeding wheat crop, the water budget of the double-cropping system, and water extraction patterns by the root systems of the crops. The experiment will be located on Brooksville clay soil and will include the following N rate treatments at time of seeding wheat after incorporation of soybean or sorghum residue:

(1) 0 lbs/A
(2) 30 lbs/A
(3) 60 lbs/A
(4) 90 lbs/A
(5) 120 lbs/A

The treatments are replicated 4 times and are arranged in a randomized block design. The soybeans and sorghum will be planted in wheat stubble by the no-tillage method. The grain sorghum will receive a sidedressing of 100 lbs/A of nitrogen.

b. Experiment No. 2. Wheat residue management in double-cropping systems. This research will determine the best and alternative methods of managing wheat straw and stubble in a double cropping system. The methods will be assessed on the basis of yields, returns, diseases, insects, water-use efficiency, limitations, problems, and applicability. The experiment will be located on Brooksville clay soil and will include the following treatments, each replicated 6 times and arranged in split-plot design. Main-plot treatments will be (1) residue burned (2) residue cut low and left on surface and (3) residue left on surface cut at normal combine level. Split-plot treatments will be (1) no-till, use herbicides, no cultivation (2) prepared seedbed, cultivate, and, (3) control weeds by cultivation.

2. Mississippi State, Mississippi (Plant Science Farm)

a. Experiment No. 3. Methods and rates of seeding wheat in a soybean-wheat system. The experiment is located on Catalpa sandy loam. The treatments are replicated 5 times and are arranged in randomized block design and include:

(1) Broadcast 1 bu/A wheat 1 month before soybean harvest.
(2) Broadcast 2 bu/A wheat 1 month before soybean harvest.
(3) Broadcast 3 bu/A wheat 1 month before soybean harvest.
(4) Broadcast 1.5 bu/A wheat after soybean harvest, disk soil lightly.
(5) Broadcast 1.5 bu/A wheat after soybean harvest, cultivate-plow the row middles.
(6) Planted 1.5 bu/A wheat with a grain drill after soybean harvest, disking, and harrowing.

The soybeans will be seeded by the no-till method following wheat harvest. An attempt will be made to produce the soybeans completely by the no-till method employing appropriate herbicides. If satisfactory weed control cannot be achieved with herbicides, cultivation will be used.

3. Booneville (Hatfield Farm)
   a. Experiment No. 4. Improved cultural practices, including wheat straw residue management, conservation tillage, and weed control in a soybean-wheat system. An experiment on Freeland fine sandy loam will consist of 8 preplant-pre-emergence treatments and 2 postemergence treatments in all combinations in a randomized complete block design with each treatment replicated 7 times. The variables include:
   (1) Conservation tillage, wheat straw management, and pre-emerge herbicides (rate/acre)
       A = 1 3/4 lbs. Lorox + 1 pt. paraquat (straw removed)
       B = ¼ lb. Sencor (straw removed)
       C = ½ lb. Sencor (straw removed)
       D = ½ lb. Sencor (straw mulched)
       E = 3/4 lb. Sencor (straw mulched)
       F = 1 pt. paraquat, 12" band in drill (straw removed)
       G = straw mulched
       H = disk and treflan (straw removed)
   (2) Postemergence herbicide
       a = none
       b = 1 lb/A Basagran

   The treatment practices will be assessed for yields, costs, returns, weed species, and magnitude of weed infestation during the season, and limitations and applicability.

B. Single-cropping soybean systems:
1. Mississippi State (Plant Science Farm)
   a. Experiment No. 5. Conservation tillage and soybean residue management (stubble mulch planting). The experiment will be located on Catalpa clay and includes the following treatment variables in all combinations:
      (A) Tillage practices:
          (1) Conventional (double-disk, "Do-all", 2X treflan, "Do-All", plant)
          (2) Stubble mulch plant (paraquat, plant)
      (B) Soybean residue quantity:
          (1) 0 lbs/A
          (2) 1500 lbs/A
          (3) 3000 lbs/A
      (C) Fungicide seed treatments:
          (1) None
          (2) Terraclor fungicide

   The treatments will be arranged in a 6 x 6 latin square design with each plot split to include or exclude the fungicide seed treatment. Each of the 12 practices will be assessed for yield, costs, returns, weed species, and magnitude of weed infestation during the season, limitations, applicability, and quality of soybean seed produced.

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b. Experiment No. 6. New concepts and techniques for better management of soil-root environment (trenching experiment). This experiment is located on Catalpa clay soil and includes the following tillage treatments (in the first year; thereafter, all plots no-tillage for 3 years) arranged in a 4 x 4 latin square design:

A = Conventional preplant tillage

B = Soil under row, in a zone 20 cm wide and 80 cm deep, was excavated and transferred into an adjacent trench

C = Soil under row, in a zone 20 cm wide and 80 cm deep, was excavated and amended while being transferred to an adjacent trench. Amendments included 22 metric tons sawdust, 11 metric tons chicken litter, 400 kg N, 50 kg P, 140 kg K, 86 kg Mg, and 18 kg Zn per hectare.

D = Amendments of sawdust, chicken litter, and fertilizer mixed in top 13 cm of soil.

This experiment is designed to improve the soybean root zone for better utilization of subsoil moisture and nutrients. The treatments will be evaluated in terms of yield, costs, returns, water extraction patterns, root distribution, nodule formation, N_2-fixation rate during the growing season, quality of soybeans produced, and disease, insect, and weed problems.

2. Greenville (Hammett Farm)

a. Experiment No. 7. Conservation tillage (stubble-mulch soybean planting). This experiment will be located on Sharkey clay and include the following treatments:

(1) Conventional tillage (shred crop following harvest, spread residue evenly on the land, chisel plow and use disc hipper to row up following harvest in fall; rehip rows in early spring as necessary to control weeds)

(2) Stubble plant (Do no fall tillage; use herbicides to kill weeds in spring and plant crops in old stubble. Use single sweep in middles for first cultivation, double shovels for later cultivation as needed.)

(3) Stubble plant (same as "2" except flail-cut before planting)

(4) Stubble plant (same as "2" except flail-cut after planting)

The treatments will be replicated 6 times and arranged in a randomized block design. These practices will be evaluated for yield, weed populations at various times, costs, and returns.

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7. SMY for FY 1974 and FY 1975:

Scientist	Grade	Title	SMY FY 1974	EST-SMY FY 1975	Other RA's to which assigned FY 1974	Other RA's to which assigned FY 1975
D. L. Myhre (001, 002)	13	Soil Scientist	1.0	1.0	-	-
J. O. Sanford (001, 002)	11	Soil Scientist	1.0	1.0	-	-
		Total	2.0	2.0		

8. CRIS Work Units in WRU:

CRIS Work Units Number	Title	Termination Date	Percent of WRU Resources Allotted to each CRIS FY 1974	FY 1975
Intramural				
7502-12310-001	Land surface modification practices for water conservation on Blackland soils	*4 JAN 74	50	0
7502-12310-002	Conservation tillage, residue management, and double-cropping for soybeans	31 DEC 78	50	100
	Total		100	100

* To be terminated in FY 74.

WRU Number: 501-7502-12310

9. Funds:

Source	Planned Obligations FY 1974	Planned Base FY 1975
Allotment		
Project Funds:		
General	76,300	76,100
Special	0	0
Distributable Funds (amounts chargeable to this WRU):	0	0
Location Support Costs	Unknown	9,700
Joint Project Costs	0	0
Subtotal--ARS Appropriated Funds	76,300	85,800
Other		
Reimbursable Funds	0	0
Trust Funds	0	0
All other funds (Hatch Act, SAES, etc. not identified above)	0	0
TOTAL AVAILABLE FUNDS	76,300	85,800

WRU Number: 501-7502-12310

10. Progress in FY 1974:

a. WRU Summary for Intramural Research:

(a) The response of soybeans to soil water stress during different stages of growth was studied using rainfall-sheltered plots in 1972 and 1973. Changes in vegetative and reproductive events, morphological characters, rate of growth, and yield characteristics caused by soil water stress at three different growth periods (vegetative, flowering, and pod-seed development) were studied in relation to the performance by plants grown with sufficient soil water supply during the entire season. A soil water stress during the vegetative stage caused the following plant responses: a significant increase in days required to produce a trifoliolate (4.2 vs. 2.6 days); a 29% reduction in leaf area (1000 vs. 1,400 cm^2/plant); an increase in maximum number of flowers (69 vs. 48) and pods per plant (21 vs. 17); and a significant increase in number of beans per pod (2.0 vs. 2.2) and total yield per plant (5.0 vs. 3.4 g). Withholding soil water during the flowering period resulted in the following significant differences in reproductive characteristics compared to unstressed control plants: a 4-day reduction in duration of flowering (34 vs. 38 days); a 4-day delay in the first day of pod set (day 76 vs. day 80); and less pods below the ninth node (10 vs. 37 pods). The response of soybeans to a soil water stress during the pod and seed development stage compared to unstressed control plants was as follows: a 4-day significant reduction in duration of pod development (19 vs. 23 days); 34% less pods above the ninth node; and a significantly higher seed weight (146 vs. 100 mg/seed). The detailed log of leaf and fruit growth of the soybean plant in relation to soil water regimes should assist in providing a basis for the development of a computer model for simulating the growth and yield of soybeans.

(b) Double-cropping, either wheat and soybeans or wheat and sorghum, is feasible in the Blackbelt. Returns to land and management in 1973 were $234/A for the wheat-soybean system and $157/A for the wheat-sorghum system. The no-tillage method of planting soybeans and sorghum proved very successful from the standpoint of obtaining a stand, reducing land preparation costs, and full land utilization.

Double-cropping with soybeans and wheat in the rolling hill section of North Mississippi produced returns to land and management which ranged from $123 to $265/A. The highest yield and returns were associated with the practice of planting soybeans in the wheat stubble, cutting the straw and spreading it evenly on the land, and using a post emergence herbicide treatment of basagran. The lowest yield and returns were associated with the conventional practice of disking in treflan after wheat harvest, planting soybeans and using no post or preemergence herbicide.

WRU Number: 501-7502-12310

(c) Publications:

1. Hesketh, J. D., D. L. Myhre, and C. R. Willey. Temperature control of time intervals between vegetative and reproductive events in soybeans. Crop Sci. 13:250-254. 1973.

2. Myhre, D. L., H. N. Pitre, M. Haridasan, and J. D. Hesketh. Effect of bean pod mottle virus on yield components and morphology in relation to soil water regimes: A preliminary study. Plant Disease Reporter 57(12):1050-1054. 1973.

3. Sanford, J. O., D. L. Myhre, and Norman C. Merwine. Double cropping systems involving no-tillage and conventional tillage. Agron. J. 65:978-982. 1973.

4. Sanford, J. O., D. L. Myhre, and Norman C. Merwine. Double crop for more grain. MAFES Research Highlights, April 1974. pp. 1, 2, 3, 6, 7.

b. Summary of Progress for Extramural Projects: None

c. CRIS Work Unit Progress Report (Form AD-421): Attached

RESEARCH WORK UNIT PROJECT DESCRIPTION – PROGRESS REPORT

U.S. DEPT. OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

DATE (Day, Mo., Yr.)

1. ACCESSION NO.	AGENCY IDENTIFICATION NO. 2	3	4	5 WORK UNIT PROJECT NO.	22-23 REG'L PROJ. NO.	6 STATUS
0017526	ARS	SWC	0100030003	SWC-030-BSTC-1		DISCONTINUED ☐ D TERMINATED ☐ E

7 TITLE

LAND SURFACE MODIFICATION PRACTICES FOR WATER CONSERVATION ON BLACKLAND SOILS

8 PERFORMING ORGANIZATION

SOUTHERN BRANCH
SWC RESEARCH DIVISION ARS
MISSISSIPPI STATE UNIVERSITY
MISSISSIPPI STATE, MISSISSIPPI 39762

12 INVESTIGATOR NAME(S) — SOCIAL SECURITY NUMBER(S)

MYHRE D L — 391-20-1699

84 PERIOD COVERED BY THIS REPORT (YR) (MO) (YR) (MO)

85 PROGRESS REPORT

The response of soybeans to soil water stress during different stages of growth was studied on a Blackland soil using rainfall-sheltered plots. A soil water stress during the vegetative stage caused the following plant responses: a significant increase in days required to produce a trifoliolate (4.2 vs. 2.6 days); 29% reduction in leaf area (1000 vs. 1400 cm^2/plant); an increase in maximum number of flowers (69 vs. 48) and pods per plant (21 vs. 17); and a significant increase in number of beans per pod (2.0 vs. 2.2) and total yield per plant (5.0 vs. 3.4 g). The response of soybeans to a soil water stress during the pod and seed development stage compared to unstressed control plants was as follows: a 4-day significant reduction in duration of pod development (19 vs. 23 days); 34% less pods above the ninth node; and a significantly higher seed weight (146 vs. 100 mg/seed). The detailed log of leaf, internode, and fruit growth of the soybean plant in relation to soil water regimes should assist in providing a basis for the development of a computer model for simulating the growth and yield of soybeans.

87 PUBLICATIONS — 88 TOTAL OTHER PUBLICATIONS THIS PERIOD (NUMBER)

Hesketh, J. D., D. L. Myhre, and C. R. Willey. Temperature control of time intervals between vegetative and reproductive events in soybeans. Crop Sci. 13:250-254. 1973.

Myhre, D. L., H. N. Pitre, M. Haridasan, and J. D. Hesketh. Effect of bean pod mottle virus on yield components and morphology in relation to soil water regimes: A preliminary study. Plant Disease Reporter 57(12):1050-1054. 1973.

Sanford, J. O., D. L. Myhre, and Norman C. Merwine. Double Cropping systems involving no-tillage and conventional tillage. Agron. J. 65:978-982. 1973.

Sanford, J. O., D. L. Myhre, and Norman C. Merwine. Double crop for more grain. MAFES Research Highlights, pp. 1, 2, 3, 6, 7. April 1974.

KEYWORD BANK (Add, delete, or change as required)

BLACKLAND-SOILS ENERGY-BALANCE SOIL-SURFACE MULCHES RAINFALL WATER-CONSERVATION SOLAR-RADIATION PLANT-WATER-RELATIONS

90 MAJOR ACHIEVEMENT ANTICIPATED IN MONTHS: (1-3) ☐ A (4-6) ☐ B (7-9) ☐ C (10-12) ☐ D (13-15) ☐ E (16-18) ☐ F OTHER ☐ G

APPROVED:

SIG. TITLE

WRU Number: 501-7502-12310

11. Summary of Need and Plans for Use of Additional Funds:

Practically nothing is known concerning the effects of cultural practices on the N_2 fixation reaction in soybeans grown in the Southern part of the United States. We need to elucidate the N_2 fixation process in determinate-type soybeans and to identify constraining or restricting factors in the fixation process for soybean yields; to determine and define the combination of soil, aerial, and biological factors which optimize N_2 fixation for maximum soybean yields; and, to develop cultural practices which optimize N_2 fixation in the field for maximum yields.

In order to make significant progress in this important area of research, we need an inter-disciplinary approach and additional funds. An excellent cooperative attitude exists among MAFES and ARS administrators and scientists in Mississippi. This cooperative relationship has been further strengthened by the creation of a Systems Methods in Agriculture Consortium between Mississippi Agricultural and Forestry Experiment Station, Agricultural Research Service of the USDA, and Tulane University. This is evidence that these agencies have taken seriously the charge by the National Academy of Science Panel that "much of agricultural research is outmoded, pedestrian, and inefficient."

In order to initiate the above proposed research, we need $10,000 which would be used for purchase of a portable gas chromatograph, associated standard gases and supplies, and a large pressure bomb apparatus for measurement of plant and root water potentials.

WRU Number: 501-7502-12310

12. Specific Requests for Adminstrator's Contingency Funds:

Title: Effects of environmental factors and cultural practices on N_2 fixation by soybeans in the South

Origin of Request: U. S. Department of Agriculture
Agricultural Research Service, Southern Region
Alabama-North Mississippi Area
Plant Science Laboratory
Mississippi State, Mississippi 39762

Donald L. Myhre
April 1, 1974

Objective of Research:

1. To elucidate the N_2 fixation process in determinate-type soybeans and to identify constraining or restricting factors in the fixation process for maximum soybean yields.

2. To determine and define the combination of soil, aerial, and biological factors which optimize N_2 fixation for maximum soybean yields.

3. To develop cultural practices which optimize N_2 fixation in the field for maximum yields.

Amount Requested (net to Location): $ 10,000

Plannned Use of Funds: Purchase portable gas chromatograph, associated standard gases and supplies, and a large pressure bomb apparatus for measurement of plant and root water potentials.

Priority Assigned by DA:

Prioritiy Assigned by AA (NPS):

Priority Assigned by PAC:

WRU Number: 501-7502-12310

13. FY 1975 Project Plan Budget Estimate:

a. Location: Mississippi State, Mississippi
WRU Number: 501-7502-12310

b. Personal Services and Benefits:

	FY 1974	FY 1975
(1) Regular Salaries and Benefits		
(a) Scientific	44,800	46,900
(b) Support	20,100	16,800
(c) Total	64,900	63,700
(2) Overtime, Holiday Pay, Differentials, Awards, L/A & WAE employment	0	0
Subtotal Personal Services and Benefits	64,900	63,700
(3) WRU Salary Detail (see attachment)		
c. Support Services:		
(1) Travel and Per Diem	600	1,000
(2) Transportation of Things	0	0
(3) Rent, Communication, and Utilities	0	0
(4) Other Services Including Reproduction	1,400	1,000
(5) Broad Form Cooperative Agreements 1/	8,700	9,000
(6) Supplies and Materials 1/	700	900
(7) Construction and Repairs 1/	0	500
(8) Miscellaneous	0	0
Subtotal Support Services	11,400	12,400
d. Support Equipment	0	0
e. Extramural Support - Research Contracts, Grants, and General and Specific Cooperative Agreements; Funded by base funds	0	0
TOTAL	76,300	76,100
f. Estimated Value of Services and Facilities Furnished by Cooperators or Grantors in Support of Your Research:	5,300	5,000

1/ See attached sheet for details and explanations for FY 1975.

WRU Number: 501-7502-12310

13. FY 1975 Project Plan Budget Estimate:[1/]

c. Support Services:

(5) Broad Form Cooperative Agreements - $9,000 for personal services (labor)

(6) Supplies and Materials - $900 for fertilizers, seed, pesticides, pipe, and miscellaneous items

(7) Construction and Repairs - $500 for custom-made laboratory equipment

WRU Number: 501-7502-12310

Plant Science Laboratory
Mississippi State, Mississippi
501-7502-12310

WRU Salary Detail
13b.(3)

Type of Fund 501
WRU No. 12310

Name	Title	Grade-Step	Type Appt.	MY of time on this WRU	Cost of Per. Service & Ben.
Donald L. Myhre	Soil Sci	1308	PFT	1.0	27,676
Joe O. Sanford	Soil Sci	1107	PFT	1.0	19,237
Betty Naugle	Secy	0508	PPT	1.0	6,680
Curtis O. Hamill	Agrl Res Aid	0409	PFT	1.0	10,092
					63,685=
TOTAL					63,700

WRU Number: 7413-12280

WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. Research Activity: Improved Drainage Systems for Agricultural Land

2. Responsible Scientist and Location:

Responsible Scientist: C. R. Camp, Agricultural Engineer

Location: USDA, ARS
146 Agricultural Engineering Building
Louisiana State University
P. O. Drawer U, University Station
Baton Rouge, Louisiana 70803

3. Contribution of WRU to Research Activity Objectives: The overall objective of developing an improved drainage system for agricultural lands will be attained for soils and crops of the Lower Mississippi Valley by accomplishing the following specific objectives:

a. Determine the effect of several constant water table depths on the growth and yield of sugarcane on Mhoon clay loam soil.

b. Determine the tolerance of sugarcane to a water table in the plant-root zone for prolonged periods of time.

c. Determine optimum design parameters for subsurface drainage systems on soils in the Lower Mississippi Valley and develop more efficient methods of assessing these parameters in the field.

d. Determine whether there is a differential drainage requirement among several varieties of sugarcane on Lower Mississippi Valley soils.

e. Determine the optimum row grade and length combination to provide efficient surface drainage and ditch outlet design.

f. Determine the period during the year when subsurface drainage is actually required for optimum sugarcane yield so that for systems that require pumping, energy may be conserved and the total cost of system operation can be minimized.

g. Determine the effect of subsurface drainage on sugarcane yield and longevity for different row configurations (ridge and flat) and row spacings (single and double drill).

Presented by Edward B. Knipling, Assistant Research Area Director, ARS, Southern Region, Mississippi Valley Area, Stoneville, Mississippi, at the ARS-SCS Workshop, April 16-18, 1974, Fort Worth, Texas.

4. <u>Changes in Direction of Work from FY 1974 to FY 1975</u>: No significant changes.

5. <u>Specific Objectives for FY 1975</u>:

a. Determine the flooding tolerance of sugarcane during the dormant season using small plots.

b. Evaluate the response of three commercial varieties of sugarcane to two different constant water tables during first ratoon.

c. Determine the response of soybeans to subsurface drainage using small plots.

d. Evaluate the response of Tunica and Sharkey soils to subsurface drainage and evaluate the response of cotton and soybeans to this drainage on field plots.

e. Evaluate, under field conditions, soil (Mhoon silty clay) and crop (sugarcane) response to various subsurface drain spacings and depths.

f. Determine the effect of row spacing and row geometry on sugarcane yield for both surface-drained and undrained conditions under field conditions.

g. Determine the effect of subsurface drainage on sugarcane growth and yield for ridge and flat row configurations on small plots.

6. <u>Plan of Work for FY 1975</u>:

a. Sugarcane will be planted in .01-acre concrete-bordered plots which are equipped to control the water table at any level from near the soil surface to 4 feet below. During the dormant and early growing season (December, January, February, and March), water tables will be raised to the surface in 3 plots each for 4, 7, and 14 days, then drained for 24, 21, and 14 days respectively. The water table in 3 additional plots will be kept below 4 feet. During the remainder of the year (April through November), water tables will fluctuate normally except in the 3 plots where the water table will be below 4 feet. Plant populations and cane yields will be determined from each plot and related to the water table treatments. Redox measurements will be made in selected plots of each treatment to determine the magnitude of reduced soil conditions.

b. Three commercial varieties of sugarcane were planted on 12 0.01-acre concrete-bordered plots in 1972. Each variety receives

constant water table treatments of 24 inches and 48 inches below the soil surface throughout the year. Cane yields will be measured and related to variety and treatment in FY 75 to determine the response of the three varieties to water table control during 1st ratoon.

c. Three commercial varieties of soybeans will be grown on 12 0.01-acre concrete-bordered plots which are equipped for controlling the water table. Each variety will receive two constant water table treatments during the crop season, 2 and 4 feet below the soil surface. Yields will be measured and related to water table treatments.

d. Subsurface drains (plastic perforated tubing) have been installed on Tunica and Sharkey clay soils in North Louisiana. The tubing was placed on grade approximately 3-1/2 feet below the soil surface with 25- and 50-foot spacings. Cotton will be grown on the Tunica soil, while both cotton and soybeans will be grown on the Sharkey soil. Wells will be installed between selected subsurface drain lines to determine the water table height with respect to the drain line. Effect of subsurface drainage on crop yield will be evaluated by comparing crop yields from 1) no subsurface drainage, 2) subsurface drains spaced 25 feet apart, and 3) subsurface drains spaced 50 feet apart.

e. Subsurface drainage (corrugated plastic perforated tubing) was installed on 20 acres of Mhoon silty clay soil near Houma, La. in the fall of 1972. Drainage outflow rates and amounts are measured continuously from each of six plots with drain line depths and spacings as follows: (1) 2-1/2 feet by 20 feet, (2) 3-1/2 feet by 40 feet, (3) 4-1/2 feet by 40 feet, and (4) 4-1/2 feet by 80 feet. Cased wells were installed between drain lines in each depth-spacing combination for measuring water table depths each week. The shape of the water table curve between drains lines will be related to measured outflow to provide subsurface drainage design criteria. Sugarcane was planted in the fall of 1973. Crop yield will be measured and related to drainage provided by various drain line depths and spacings.

f. A study to determine the effect of row spacing and row configuration under both subsurface drained and undrained conditions on sugarcane growth and yield was initiated in the fall of 1973. The three treatments were: (1) conventional 6-foot row spacing planted on a ridge, (2) 6-foot row spacing planted flat, and (3) 7-foot spacing, double drill spaced 30 inches apart, planted flat. These treatments, replicated 3 times each, were installed on Mhoon sicl soil with subsurface drainage provided by plastic drain lines 4-1/2 feet deep and 80 feet apart. The same replicated treatments were also installed on a similar plot nearby with the same soil type

but without subsurface drainage. Sugarcane yield and growth measurements will be made during the 1974 growing season.

g. Twelve 0.01-acre concrete-bordered plots were planted to sugarcane in the fall, 1973 to determine the effect of row configuration on sugarcane response under two constant water table conditions. Sugarcane was planted flat (furrow opened with soil surface flat) and on the conventional ridge (build ridge then open furrow for planting) on the twelve plots and in a control area nearby but outside the area of influence of the controlled water tables. Two water table treatments, 30 cm and 120 cm below the soil surface will be superimposed on the planting treatments and replicated three times. The water table in the control area will be allowed to fluctuate naturally. Sugarcane growth and yield response will be determined during the 1974 growing season.

WRU Number: 501-7402-15480

WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. Research Activity: Equipment for Cotton Production and Harvesting Systems.

2. Responsible Scientist and Location:

Responsible Scientist: E. B. Williamson, Research Leader

Location: Field Crops Mechanization Research Laboratory
Mississippi Valley Area
USDA, ARS
Stoneville, Mississippi 38776

3. Contribution of WRU to Research Activity Objectives:
Reduce machinery, labor, and material inputs and production costs in growing and harvesting cotton by developing more efficient equipment and systems of production and harvesting.

4. Changes in Direction of Work from FY 1974 to FY 1975:
No significant changes planned.

5. Specific Objectives for FY 1975:

a. Complete development of a new unified wide-bed system of cotton production that allows differential treatment of plant and traffic zones.

b. Determine the effects of trench tillage and variations of the wide-bed cultural system on heavy clay soils.

c. Develop, assemble, and modify more economical harvesting equipment and procedures for soils of low yielding potential.

d. Determine effects of twin-drill planting patterns on earliness and harvesting efficiency.

e. Design, construct, and develop experimental field and plot-research equipment for improved cultural-machine systems.

f. Collect verification data and test model hypothesis for computer simulation models as an aid to regional project model builders.

g. Design and develop improved equipment for applying carbon as a protectant for herbicides.

h. Determine the effects of plant pruning and improved defoliants on yield, harvesting efficiency, and lint quality.

i. Design, develop, and evaluate a twice-over stripper harvester in various wide-bed and conventional row patterns.

6. Plan of Work for FY 1975: The four levels of primary tillage evaluated in the wide-bed cultural system test in FY 1974 will be compared again on sandy loam soil. Instrumentation has been assembled for obtaining more data on soil physical characteristics and plant response as affected by tillage treatment. Five cultural treatments composed of different row patterns and methods of zone tillage will be compared in large field plots on Sharkey clay soil. Alternative harvest methods will be used on specially designed treatment and composite samples will be submitted for ginning and fiber analysis. Development of the Stoneville triplex subsoiler, saw type stalk shredder, modified doall harrow, automatic recirculating sprayer, CFT chemical applicator, trench-tillage implement, twin-row drum planter, and triease applicator will be continued and evaluated in research field plots.

7402 15480

6. (continued)

Five plant populations in both single and twin drill patterns will be evaluated for yield, earliness, and harvesting efficiency on wide and conventional beds. Computer simulation models will be evaluated for applicability to the specific objectives of current research projects with emphasis on the evaluation of output with respect to objectives. Design, develop, and evaluate a combination automatic planter and sprayer that is synchronized to apply hills of cotton and spots of carbon simultaneously. Early pruning of fast growing cotton plants will be accomplished with a specially designed mechanical topper. The latest improved defoliants will be evaluated on both wide and conventional beds with two types of harvesters. A twice-over cotton stripper will be designed, constructed, and evaluated in both laboratory and field tests.

ARS Soil and Water Pollution Research Program at Baton Rouge, Louisiana
P. O. Drawer U, University Station, 70803 Phone 504/348-0181 X326

I. Research Personnel: Dr. J. F. Parr (Research Leader), Dr. G. H. Willis, Mr. S. Smith, Mr. B. R. Carroll, Dr. L. M. Southwick

II. Research Activity: Control of Pesticides in Soil and Water

III. Research Objectives:

Developing improved methods and management systems for prevention, treatment, and control of soil and water pollution from agricultural chemicals in the Lower Mississippi Valley by:

A. Determining the fate and persistence of agricultural chemicals (pesticides and fertilizers) relative to their potential role as pollutants of soils and natural waters.

B. Determining the rate and extent of pesticide degradation in soil and natural waters (by both chemical and biological mechanisms).

C. Seeking ways of accelerating the degradation of persistent chemicals through modification of soil and water management practices.

D. Developing methods for controlling agricultural pests by supplementing chemical control practices with nonchemical techniques.

E. Increasing our knowledge of the role of sediment in adsorption, transport, desorption, and degradation of pesticides.

F. Relating residual pesticide levels within a watershed to soil types and their associated chemical, physical, and biological properties.

G. Determining the rate and extent of pesticide volatilization losses to the atmosphere.

IV. Summation of Research Results (not for publication):

A. From a study (cooperative with USDA Sedimentation Laboratory at Oxford, Mississippi) on an 80-acre watershed planted to cotton (located near Clarksdale, Mississippi), it was determined that:

1. From a total of 66.55 inches of rainfall, 31.77 inches ran off from soil with 0.2% slope, removing 12.85 tons of soil/acre/year.

Presented by Guye H. Willis, Acting Research Leader, ARS, Baton Rouge, La., at the ARS-SCS Workshop, April 16-18, 1974, Fort Worth, Texas.

2. The principal means of pesticide transport from the watershed was by adsorption to suspended sediment.

3. Of the 18 lbs. of toxaphene/acre (9 ppm) applied to the watershed in May - September 1972, residual soil concentrations in May 1973 ranged from 1 to 55 ppm; of the 7 lbs. DDT/acre (3.5 ppm) applied in July - September 1972, residual soil concentrations in May 1973 ranged from 1 to 2.7 ppm.

4. Preliminary data from core samples taken from a small, shallow pond located within the watershed suggest that both toxaphene and DDT are degrading at accelerated rates in bottom sediments.

B. From studies at Baton Rouge, Louisiana

1. Runoff losses for fenac, trifluralin, linuron, and diuron from sugarcane, soybean, and cotton plots were minimal, generally less than 0.1% of that applied. Greatest losses resulted from heavy rainstorms that occurred soon after pesticide application.

2. Degradation of DDT, toxaphene, and trifluralin occurs more rapidly in anaerobic environments than aerobic environments. Evidence indicates the degradation resulted from microbiological activity.

3. Field studies with DDT and dieldrin indicate that volatilization may be the most important pathway for pesticide transport in the environment.

4. Fallow flooding soil amended with organic material (sugarcane bagasse) substantially reduced viable johnsongrass seed populations. There was a progressive decrease in seed populations as the duration of flooding increased (3 to 7 months).

WRU Number: 7402-12070

WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. Research Activity: Weed Biology and Mechanism of Control

2. Responsible Scientist and Location:

   Responsible Scientist: C. R. Swanson, Laboratory Chief

   Location: USDA, ARS
Southern Weed Science Laboratory
P. O. Box 225
Stoneville, Mississippi 38776

3. Contribution of WRU to Research Activity Objectives:

   a. The overall objectives of developing improved methods for the control of weeds in the South will be attained by pursuing the following sub-objectives:

      (1) Investigate the physiological processes and ecological or anatomical factors which influence or regulate the formation, development, dormancy and germination of weed seed and propagules.

      (2) Determine the anatomical and cytological characteristics of weeds at different life cycle stages in order to improve weed control efficiency.

      (3) Determine the influence of herbicides or related treatments upon the anatomy and ultrastructure of weeds and crops.

      (4) Discover and characterize the relationship between stage of growth, physiological condition, and metabolic activity of weeds and crops of the South in relation to sensitivity or resistance to herbicides and associated chemicals.

      (5) Determine how environmental variables influence the physiological response of weeds to herbicides.

      (6) Determine how weed growth and metabolic activity vary in response to variables of the ambient environment.

Presented by C. R. Swanson, Laboratory Chief, ARS, Southern Weed Science Laboratory, Stoneville, Mississippi at the ARS-SCS Workshop, April 16-18, 1974, Fort Worth, Texas.

WRU Number: 7402-12070

(7) Discover and characterize those life processes in hard-to-kill weed species that differ from those in crops in order to improve selective weed control.

(8) Investigate the mode and mechanism of action of herbicides in weeds and crop plants.

WRU Number: 7402-12070

4. Changes in Direction of Work from FY 1974 to FY 1975:

Present work on the life history studies and control of aquatic weeds will be reported under WRU 7402-12230.

5. Specific Objectives for FY 1975:

The specific objectives are best expressed according to the three research units under this WRU.

Botanical and Ecological Studies on Weeds

a. Continue studies on the influence of seed hormone levels, seed metabolism, seed anatomy and chemical additions upon the onset of dormancy in developing seed of common purslane, prickly sida and other malvaceous weeds.

b. Continue studies on the influence of environment, growth regulators, seed metabolism and seed hormone levels on the dormancy and germination of mature common purslane, prickly sida and selected malvaceous weed seed species.

c. Continue a study on the seed viability and longevity of 20 weed species after seed burial under natural conditions at Stoneville, Mississippi.

d. Determine anatomical characteristics of selected weed species at different life cycle stages that correlate with susceptibility or resistance of the weed to control measures.

e. Determine anatomical characteristics of certain malvaceous seeds and fruits that correlate with dormancy of the seeds.

f. Study the anatomical location and physiological significance of calcium oxalates in *Amaranthus* weed species.

Physiology of Weeds and Herbicides

a. Develop a growth model based on physiological data for six problem weeds.

b. To determine the effects of temperature, relative humidity, and leaf water potential on photosynthesis rates of cocklebur leaves treated with bentazon.

c. To determine the effect of temperature and light intensity on the development of photosynthetic competence in velvetleaf seedlings in the presence and absence of fluometuron.

WRU Number: 7402-12070

Biochemistry of Weeds and Herbicides

a. To continue investigations on the mode and mechanism of action of herbicides on susceptible and resistant plants. Propanil-resistant weeds will be screened for aryl acylamidase enzymes that can be purified and characterized. Studies will be initiated on the herbicide, glyphosate, to determine its mode and mechanism of action in plants. Key enzyme systems of resistant and susceptible plants will be examined with respect to interference by glyphosate and to metabolism of glyphosate.

b. To continue comparative physiological/biochemical studies of crop and weed species. More specifically: 1) molecular causes of dormancy in purslane, cocklebur, and prickly sida seeds will be investigated further, 2) photosynthetic carbon metabolism studies of crop and weed species will be initiated, and 3) glyphosate affects on protein synthesis will be investigated as part of a team effort.

6. Plan of Work for FY 1975:

Botanical and Ecological Studies on Weeds

a. Prickly sida and velvetleaf will be grown in the greenhouse or in growth chambers. At selected days after anthesis, seeds will be removed from the mother plant, treated and incubated to determine factors that correlate with or influence onset of seed dormancy. Treatments will include growth regulators, (abscisic acid, GA_3, kinetin, ethylene, etc.), light quality (red, far-red), seed and fruit extracts, soaking of seeds in water, and different gases (O_2, CO_2, N_2). The purpose of the study is to determine how the onset of dormancy is controlled in developing weed seeds.

b. Dormancy of common purslane seeds will be broken by seed exposure to light in the laboratory. Germination inhibitors and dormancy inducing treatments (i.e., abscisic acid, far-red light) will be applied to the seeds at various times after breaking of dormancy in order to determine how far pregermination events may proceed before germination can be stopped. The metabolic events in, and anatomical characteristics of, seeds prior to germination (radical protrusion) will be determined. The purpose of the study is to determine and distinguish between physiological events essential for induction of germination and physiological events essential for radical growth. Those events responsible only for induction of germination will be candidate points of attack in subsequent studies on how to break weed seed dormancy and induce germination.

c. Mature common purslane and redroot pigweed seeds will be collected from field-grown plants at the times when the seeds are normally dispersed. The germination characteristics (temperature and light requirements) of the seeds collected at different times of the growing season will be determined. The purpose is to determine if seed dormancy of these two species is influenced by environmental conditions under which the seeds are produced.

d. Weed seeds buried in the field for 0.5 and 1.5 years will be recovered and the percentage of viable seed of each of 20 species surviving the burial period will be determined.

e. Anatomical and histochemical techniques will be used to delineate areas in malvaceous weeds that have lignification, suberization, and other tissue formations that could influence herbicide penetration and movement in these weed species. Plant parts at various life cycle stages will be sectioned, stained, and examined in order to determine tissue structures that may influence susceptibility to certain herbicides. The anatomical and histochemical studies will be correlated with weed responses to certain herbicides.

f. Anatomical and histochemical techniques will be used to delineate histological changes that occur in malvaceous weed seeds (i.e. prickly sida) during their development on the plant. Fruits and seeds of various stages of development will be removed from the plant, sectioned, stained and examined histologically. The histological findings will be correlated with results of physiological studies on similar seeds in attempts to delineate structures contributing to seed dormancy.

g. At different life cycle stages, plant parts of *Amaranthus* species will be sectioned and the occurrence of calcium oxalate deposites determined. The possible significance of calcium oxalate crystals in plant tissues upon the growth and development of the weed, will be evaluated.

Physiology of Weeds and Herbicides:

a. Growth modeling will be done by correlating dry weights and leaf areas of plants grown in growth chambers with photosynthesis and respiration rates of similar plants.

b. Cocklebur plants will be grown in growth chambers under different temperature, relative humidity, and soil moisture regimens. Bentazon will be applied to the leaves and its effect on photosynthesis and leaf necrosis will be determined.

c. Velvetleaf plants will be grown from seeds in the presence and absence of fluometuron under controlled conditions. The effect of temperature and light intensity on the development of photosynthetic competence in the untreated plants will be compared to that of plants treated with fluometuron.

Biochemistry of Weeds and Herbicides

a. Enzyme preparations will be obtained from resistant and susceptible weed and crop plants. These crude enzyme preparations will be tested for hydrolysis of propanil and effects and/or metabolism of glyphosate. Certain enzymes will be purified by usual biochemical procedures, including polyacrylamide gel electrophoresis and isoelectric focussing. Purified enzymes will be tested for substrate specificity, activation and inhibitor effects, and pH and temperature optima.

b. Comparative physiology/biochemistry studies will include:

(1) Molecular approaches to weed seed dormancy will include determining the time (embryogenesis or onset of germination) of RNA synthesis of species essential to germination--data will be compared to crop seeds. Polyacrylamide gel electrophoresis and radioactive isotopes will be used in these studies.

(2) Comparative photosynthetic carbon metabolism studies of crop and weed species will initially consist of determination of primary products in order to establish any qualitative differentiation of pathways which may exist. Radioactive isotopes, chromatography, and growth chambers will be used.

(3) Studies will be conducted to determine whether glyphosate competes with glycine in aminoacylation reactions. If so, further investigations will include specificity tests using purified glycylaminoacyl-tRNA synthetases and column chromatographic separation of charged glycyl-tRNAs. Radioactive isotopes will be used.

WRU Number: 7402-12070

10. <u>Progress in FY 1974</u>:

a. <u>WRU Summary for Intramural Research</u>:

(1) <u>Botanical and Ecological Studies on Weeds</u>

Seeds of prickly sida became dormant as they developed on the plant from 16 to 21 days after anthesis. The seed dry weight decreased slightly and the seed water content decreased greatly during the onset of dormancy in developing seeds. The mature, dormant prickly sida seeds imbibed water very slowly. Afterripening in dry storage for four months enabled the seeds to imbibe water rapidly and germinate within 24 hours after start of incubation. Dormancy was also broken by sulfuric acid treatments, certain organic solvents and seed punctures over the radical. However, a water-permeable sheath surrounding the embryo beneath the seed coat somehow functioned in prickly sida dormancy. Imbibed, nonafterripened seed required light or alternating temperatures for maximum germination. The breaking of prickly sida dormancy was more complex than simply inducing water imbibition. Growth promoters increased slightly during the breaking of dormancy and the early stages of germination, however, the growth inhibitor contents remained high in both dormant and nondormant seeds. A lack of growth promoters may be important in prickly sida dormancy.

Storage studies with mature, dormant common purslane seed showed that simply drying seed from 15% to 6% moisture, increased germinability in the light. Low temperature storage for 8 to 12 months decreased germinability in the light.

Between 80% and 95% of white morningglory, velvetleaf, sicklepod, spurred anoda, small moonflower, common purslane, evening primrose, johnsongrass, goosegrass and crabgrass seeds remained viable after burial for 6 months under natural conditions. Only 27% to 32% of prostrate spurge, redvine and checkweed seeds remained viable at the end of the 6-month burial period.

Anatomical studies were conducted on *Sida spinosa* (prickly sida) and *Xanthium pensylvanicum* Wallr. (common cocklebur) to determine if a seed structure

could physically be the cause of dormancy. Preliminary investigations show that the dormancy of newly harvested sida seed may indeed be due to, or at least partially so, a physical structure. However, with cocklebur even though many highly interesting cross-sections and longitudinal-sections were obtained, no physical reasons for dormancy could be demonstrated. In anatomical studies with *Anthernanthera philoxeroides* (alligatorweed) it was demonstrated that the nodal area contained a considerable concentration of calcium oxalates. If these oxalate compounds have any particular function it is not known as yet. The crystal composition of calcium oxalate has been confirmed by infrared and histochemical analysis. The crystal formation apparently follows the growth cycle. In the spring and summer months the calcium oxalate crystals reach a peak in concentration and decline to at least one half that number in the winter months. (WRU 12070-007 approval pending).

(2) Physiology of Weeds and Herbicides

The rate of increase in dry matter of six important weeds is greater than that of cotton or soybean. This holds true for three temperature regimens which typify spring and midsummer in the South. However, the size a plant attains in any given time period is strongly dependent on seed size. Under a day/night temperature regimen of 32/21 C with 14 hour days, cocklebur, johnsongrass and redroot pigweed achieved greater dry weights than either cotton or soybean during a 21 day growth period following emergence. While velvetleaf, spurred anoda and prickly sida did not get as large as cotton or soybean under these conditions, these weeds would have overtaken the crop species if growth had continued at the observed rates.

The action of bentazon, a new selective herbicide for use in soybean, is influenced by light intensity. Bentazon destroys photosynthetic competence about one hour following application to cocklebur leaves at 0.25 kg/ha, but respiration is not directly affected.

Velvetleaf seedlings develop photosynthetic competence within 4 days after imbibition at 33/23 C (day/night temperature), and photosynthesis on a leaf area basis reaches a maximum at 5 days. This maximum rate of photosynthesis in developing cotyledons is 40%

more rapid than that of mature leaves of the species. In effect, this initial burst of photosynthesis gives velvetleaf seedlings additional reserves which they would not have if the photosynthetic burst did not occur. Ten ppm fluometuron, an important herbicide in cotton production, applied prior to germination, completely inhibited the development of photosynthetic competence in velvetleaf seedlings, but respiration was affected only indirectly.

(3) Biochemistry of Weeds and Herbicides

Polysome formation of two weed seed species displaying light-controlled dormancy, common purslane and red-root pigweed, and one requiring only afterripening, prickly sida, was investigated. Ribosome extractions were made from imbibed seeds prior to germination (radical protrusion), and ribosomal profiles were obtained on sucrose density gradients. Light was found to stimulate polysome formation in purslane and pigweed seeds, even though these seeds were fully imbibed in the dark. Polysome formation in sida seeds was found to be dependent on imbibition alone. Only purslane seeds displayed sensitivity to actinomycin D, suggesting that transcription is a prerequisite to the light-stimulation of polysomes.

Isocitratase, key enzyme of glyoxysomes activity, was found to coincide with the appearance of the light-stimulated polysomes and to be inhibited by actinomycin D and cycloheximide. These data suggest that isocitratase mRNA is lacking in purslane seeds, *de novo* synthesis of the enzyme occurs, and there is an important role for isocitratase in germination.

Additional work is required to prove that light triggers transcription of essential germinative mRNAs in seeds displaying light-controlled dormancy.

Initiated an ultrastructural study of the cytological changes that occur in cocklebur (*Xanthium pensylvanicum* Wallr.) after treatment with the herbicide, bentazon. Herbicide treatment does not result in any immediate or specific ultrastructural changes; however, general cytoplasmic alterations that are similar to those observed in senescing leaves occur after several hours and lead to necrosis. (WRU 12070-006 approval pending)

Eighteen genera of weeds, encompassing 11 plant families, were tested for arylacylamidase activity with propanil as substrate. Ten commercial soybean cultivars were also examined for arylacylamidase activity. Some of the weed species with high levels of activity are resistant to propanil. There was no indication of activity in the soybean cultivars. Further work is necessary to compare the arylacylamidase in red rice to enzyme properties from commercial rice varieties in order to determine the mechanism of tolerance to propanil. (WRU 12070-005 approval pending).

(4) Publications:

Egley, G. H. 1974. Dormancy variations of developing common purslane seed. (Manuscript in progress for publication in Weed Sci.)

Egley, G. H. 1974. Influence of storage temperature and seed moisture upon germination of common purslane. 1974 Annual Meeting of the Southern Section of the American Soc. of Plant Physiologist. (Unpublished abstract).

Egley, G. H. and B. J. Reger. 1974. Seed coverings and prickly sida seed dormancy. Abstracts, 1974 Meeting of the Weed Sci. Soc. Amer., page 11.

Newton, R. J. and G. H. Egley. 1974. Growth regulators and prickly sida dormancy. 1974 Annual Meeting of the Southern Section of the American Soc. of Plant Physiologists. (Unpublished abstract).

Potter, J. R. and William P. Wergin. 1974. Effects of fluometuron on photosynthesis, respiration, and ultrastructure of developing velvetleaf seedlings. Plant Physiol. Abstract to be presented at annual meeting. In press.

Reger, Bonnie J., G. H. Egley, and C. R. Swanson. 1974. Light-stimulation of polysome formation in common purslane seeds. Abstracts, 1974 Meeting of the Weed Sci. Soc. Amer., pages 86-87.

Reger, Bonnie J., G. H. Egley, C. R. Swanson, and E. W. Smith. 1974. Polysome formation in relation to seed dormancy of common purslane, prickly sida, and redroot pigweed. 27th Annual Meeting S. Weed Sci. Soc. In press.

WRU Number: 7402-12070

Reger, Bonnie J., C. R. Swanson, and G. H. Egley. 1974. Induction of polysomes and isocitratase in common purslane seeds prior to germination. 1974 Annual Meeting of the Southern Section of the American Soc. of Plant Physiologists. (Unpublished abstract).

Reger, Bonnie J., G. H. Egley, and C. R. Swanson. 1974. Light-stimulation of polysome formation in common purslane seeds. Plant Physiol. (Manuscript approved for publication).

Wergin, William P. and John R. Potter. 1974. The ultrastructural and physiological effects of bentazon on leaves of cocklebur. Abstracts, 1974 Annual Meeting of the Weed Sci. Soc. Amer.

Hoagland, Robert E. 1974. Arylacylamidases in plants resistant and susceptible to propanil. 27th Annual Meeting S. Weed Sci. Soc. In press.

b. Summary of Progress for Extramural Projects:

0710-11-12CA Weed Seed Population, Dormancy, and Viability in Soils. R. L. Caine and G. H. Egley

Over 120 soil samples (2 inch diameter columns, 0 to 12 inches deep) were collected from four soybean fields in the Mississippi Delta near Pine Bluff, Arkansas. Weed seeds in the soil samples were detected, enumerated and identified. Viable seeds of tumble pigweed, prostrate pigweed and yellow foxtail were found in three of the four fields. Carpetweed and tall lettuce were detected in two of the fields with one field very abundant in carpetweed. Other species detected in one of the four fields were red sorrel, water hemp, narrow leaf vetch and stinkgrass. At least five other unidentified species were also found. The seeds were detected throughout the top 12 inches of soil. Seeds of any one species were not uniformily distributed throughout a field. Weed seeds in soil samples collected from cotton fields will also be investigated.

WRU Number: 7402-12230

WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. Research Activity: Aquatic Weeds and Their Control

2. Responsible Scientist and Location:

   Responsible Scientist: C. R. Swanson, Laboratory Chief

   Location: USDA, ARS
   Southern Weed Science Laboratory
   P. O. Box 225
   Stoneville, Mississippi 38776

3. Contribution of WRU to Research Activity Objectives:

   a. The overall objective of developing improved methods for the control of aquatic and bank weeds in the South will be attained by pursuing the following sub-objectives:

      (1) Conduct life history studies on aquatic weeds in order to improve weed control through a better understanding of their physiological, biochemical, and ecological characteristics.

      (2) Evaluate the effects of environmental variables on growth, reproduction, and other eco-physiological phenomena of aquatic and noncropland weeds.

      (3) Select and explore intensively unique physiological and biochemical processes of selected species, with emphasis on nitrogen and mineral element nutrition and accumulation.

      (4) Determine growth and development characteristics of selected species during their life cycles.

      (5) Investigate ecological associations of selected species with microorganisms, and the influence of microorganisms on physiological processes of the weeds.

      (6) Develop biological and ecological methods of control in order to reduce dependence on herbicides.

      (7) Investigate whether introduced host-specific biocontrol agents will become established on exotic aquatic and noncropland weeds.

(8) To investigate the occurrence and impact of native insects normally associated with the weeds needing control.

(9) To determine whether plant vigor, stage of growth, and other aspects of aquatic weed growth could be altered by chemical, fertilizer, or mechanical treatments to stimulate more effective control by biological agents.

WRU Number: 7402-12230

4. Changes in Direction of Work from FY 1974 to FY 1975:

No significant changes in direction.

5. Specific Objectives for FY 1975:

a. To continue investigation on the interactions of light, temperature, and anaerobiosis on budbreak of aquatic and amphibious amaranths and polygonaceous species. Specific emphasis will be directed toward elucidating the role of anaerobiosis on inhibition of budbreak from submerged alligatorweed nodes.

b. To continue investigations on physiological-ecological observations on alligatorweed with emphasis on occurrence and extent of propagule dissemination and on environment-plant-biological suppressant interactions.

c. To investigate the effect of nitrogen-fixation by blue-green algae on the growth of aquatic macrophytes, e.g., great duckweed (*Spirodela polyrhiza*).

d. To investigate the interaction of nitrogen and calcium nutrition on nitrate accumulation and on the formation of calcium oxalate crystals in tissues of aquatic weeds such as alligatorweed and great duckweed; also to study the physiological role of the oxalate crystals.

e. To continue biological control studies with emphasis on the following:

(1) Continue inventory and biological studies of the insects that feed on alligatorweed.

(2) Study ways to establish and maintain colonies of the alligatorweed flea beetle.

(3) Continue inventory and biological studies of the insects that feed on *Spirodela*, one of the duckweeds.

(4) To continue studies of the *Altica* flea beetles of amphibious and terrestrial onagraceae.

6. Plan of Work for FY 1975:

a. Budbreak will be investigated by subjecting vegetative propagules to various treatments of submergence, aeration, and light intensity in the laboratory and growth chambers.

b. A series of biological field stations will be periodically visited to make observations regarding propagule dissemination and other physiological-ecological information.

c. Gas chromatography will be employed to assay for nitrogenase by the acetylene-ethylene method in laboratory and field studies of nitrogen fixation by blue-green algae.

d. Nutritional studies will involve hydroponics; plant tissue will be analyzed for nitrate ion with a specific-ion electrode and for oxalate with a titrametric method; enzyme assay will be performed in a search for the physiological role of oxalate crystals.

e. Field studies or surveys will be continued on the bionomics of insects that feed on alligatorweed and on *Spirodela*, one of the duckweeds.

f. Methods of maintaining and establishing colonies of the alligatorweed beetle will be explored in the field and in artificial cultures.

WRU Number: 7402-12230

10. Progress in FY 1974:

a. WRU Summary for Intramural Research:

Submergence has been demonstrated to have a major inhibiting effect on budbreak of alligatorweed nodes held in the dark. Further investigation will be required to determine the nature of this inhibition.

Refractometer measurements of total dissolved solids could not be correlated with sugar determinations on alligatorweed tissue. The shade of a tupelo brake had no significant effect on the growth of alligatorweed. Alligatorweed was shown to require high levels of nitrogen for normal growth.

Hydrographic flux was demonstrated to affect alligatorweed in that high flood waters spread propagules downstream while suppressing budbreak and growth in the early spring. High flood waters on channelized streams prevent non winter-diapausing *Agasicles* from having the continuous cover of alligatorweed needed for survival. Extensive arboreal brakes limit the downstream spread of vegetative propagules.

Two native disonychine beetles (*Disonycha collata* and *D. xanthomelas*) were observed to have a major impact on terrestrial alligatorweed in those areas where there is sufficient sheltering vegetation for over-wintering on the bank above the high water level.

Subfreezing temperatures that persisted for an uninterrupted period of 4 days did not eradicate, as mistakenly assessed during January 1973, an established colony of *Agasicles* at Lake St. John, LA.

Additional records of occurrence were made of terrestrial species of *Altica* attacking aquatic *Jussicea* presumably after seasonal decline of terrestrial and/or amphibious host plants.

This work summarized here has been conducted under CRIS Work Units 7402-12230-001 (approval pending).

Publications:

Quimby, Jr., P. C. and G. B. Vogt. Aspects of alligatorweed in the Mississippi Valley. (Abstract) Proceedings So. Weed Sci. Soc. 1974.

WRU Number: 7402-12230

Quimby, Jr., P. C. Environmental effects on budbreak of alligatorweed. Abstracts 1974 Meeting of the Weed Sci. Soc. Amer. 1974.

b. <u>Summary of Progress for Extramural Projects</u>:

None

WRU Number: 7402-14760

WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. Research Activity: Control of Pesticides in Soil and Water

2. Responsible Scientist and Location:

   Responsible Scientist: C. R. Swanson, Laboratory Chief

   Location: USDA, ARS
   Southern Weed Science Laboratory
   P. O. Box 225
   Stoneville, Mississippi 38776

3. Contribution of WRU to Research Activity Objectives:

   Research Activity Specific Objective B: Devise cultural, biological, physical, and chemical methods through basic research for maintaining or decreasing pesticides in soils and water.

   a. To quantitatively evaluate the various loss and degradation pathways involved in the ultimate disposition of individual herbicides and their biologically-active products in the environment following field application using normal agricultural practices.

   b. To evaluate each major loss pathway in relation to measurable edaphic, climatic, and agricultural variables in order to develop mathematical models to predict environmental pollutant potentials for individual herbicides.

WRU Number: 7402-14760

4. Changes in Direction of Work from FY 1974 to FY 1975:

No changes in direction of work are planned.

5. Specific Objectives for FY 1975:

a. Evaluate the behavior, movement, and persistence of herbicides in soil, air, and water, as affected by measurable climatic, edaphic and agricultural factors.

(1) Quantitatively assess the soil adsorption-desorption equilibria and mobility of various herbicides as a function of soil properties and agricultural practices.

(2) Quantitatively monitor the rate of dissipation and downward movement of herbicides in soil under greenhouse and field conditions.

(3) Measure the quantity of herbicide removed from a field by runoff events, and relate this removal to climatic, edaphic, and agricultural factors.

(4) Quantitatively evaluate the vapor losses of herbicides from soil.

(5) Evaluate plant uptake of herbicides as a mode of dissipation.

(6) Assess herbicide loss during application with regard to movement away from the proposed site of application.

(7) Qualitatively and quantitatively evaluate the chemical and physico-chemical reactions of arsenic, phosphate, and arsenic-containing herbicides with metal oxides and soil surfaces.

b. Evaluate the total persistence of an herbicide in the environment following field application.

6. Plan of Work for FY 1975:

The reaction, precipitation, and solubility of precipitates of organoarsenate ions with the salts of iron, aluminum, and calcium will be studied as a function of pH in a solution-mixing experiment. The reaction of these organoarsenate ions will be compared to the behavior of phosphate and arsenate ions under similar conditions.

WRU Number: 7402-14760

The soil adsorption-desorption equilibria and mobilities of herbicides will be studied in the laboratory. Equilibration studies will be conducted using batch or flow-displacement techniques, with emphasis on evaluating the kinetics of the adsorption-desorption equilibria. Mobilities will be determined using flow techniques. Radiolabeled herbicides will be used to increase analytical sensitivity and efficiency. A series of 16 soils with well-defined properties will be used to allow evaluation of adsorption and movement as a function of soil properties.

The rate of dissipation of four phenylurea herbicides and their downward movement under field conditions will be monitored by bioassay and chemical analysis of soil samples from a 3-year rotational study of fluometuron and diuron on cotton and chlorbromuron and linuron on soybeans.

The dissipation rate of metribuzin in two soil types in the greenhouse will be determined by bioassay and chemical analysis.

The rate of fluometuron dissipation from soil, depth of penetration into soil, and loss by runoff is being determined in a field study at Stoneville, MS and also at Raleigh, NC; Clemson, SC; Bushland, TX; Knoxville, TN; and Rio Piedras, PR. This represents cooperation through the S-78 regional research project entitled "Herbicide Movement from Application Sites and Effects on Non-target Organisms."

Trifluralin and metribuzin volatilization losses will be studied in the greenhouse and field using a stainless-steel enclosure equipped with a vacuum-operated trap in which the vapors will be collected in a suitable solvent. Various soils and moisture conditions will be evaluated with this system. Additional air sampling will be conducted in the field using a similar type trap.

Dissipation of trifluralin and metribuzin from soil by plant uptake will be evaluated by analyzing soybean plants grown in treated soil in the greenhouse or field. The plants will be analyzed at various stages of growth. The parent herbicide, as well as any known, recognizable metabolic products, will be determined.

Laboratory and field studies will be conducted to evaluate the loss of trifluralin and metribuzin between the spray nozzle and the soil surface. This work will be done by measuring the quantity of herbicide leaving the nozzle and that impinging on the soil surface. The difference will represent a preliminary estimate of the efficiency of this agricultural operation.

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Trifluralin and metribuzin will be applied to a field plot using normal agricultural practices. Quantitative estimates of the quantities of these herbicides leaving this plot by surface runoff, percolation into ground water, volatilization, and plant uptake will be obtained by sampling and analyzing water, sediment, air, and plants. Soil samples will be taken periodically to monitor the rate of disappearance from soil. Climatic variables will be determined using standard meteorological instruments.

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10. Progress in 1974:

a. WRU Summary for Intramural Research:

Preliminary field and laboratory studies were conducted by members of the research unit to evaluate procedures and techniques to be used in a team project evaluating the persistence of an herbicide in the environment. Analytical techniques for trifluralin and metribuzin in soil and water have been evaluated using gas chromatography with an electron capture and an electrolytic conductivity detector. Specialized glassware and related equipment for studying solubility and interfacial properties have been constructed. Meteorological equipment has been obtained, calibrated, and field tested. Equipment and instrumentation is being collected and constructed to allow sampling of runoff water and sediment, percolating water, and herbicide vapor from a treated field.

Greenhouse and field sampling studies indicated that the residual levels of trifluralin, nitralin, fluchloralin, profluralin, dinitramine, and A-820 decreased to low levels after 4 to 8 months. Residues were evaluated by both bioassay and chemical analysis.

Soil sample analyses from the regional S-78 field study indicated that fluometuron is disappearing from soil fairly rapidly in the humid southeastern states of Mississippi, North Carolina, South Carolina, and in Puerto Rico. Disappearance is less rapid in the more arid location of Bushland, TX. Very little movement below 12 inches has been detected.

Adsorption and mobility studies indicate that metribuzin is adsorbed weakly, and is quite mobile in soils. The clay-organic matter complex is of significant importance in determining adsorption and mobility indices for this compound.

Chlorbromuron is adsorbed strongly by soil and is degraded rapidly in soil. Degradation appears to be primarily a function of microbiological activity and results in no apparent accumulation of intermediate metabolites.

Fluometuron adsorption-desorption studies resulted in data of sufficient precision to make mathematical interpretations of the isotherms. The equation ($x/m = K_1C_e + K_2C_e^2$) proposed by Lambert best fit the experimental data. Soil organic matter was highly associated with the K_1 values.

Slurry fixation studies with phosphate, arsenate, DSMA, and cacodylic acid indicated that the sorption of all four chemicals onto soils was strongly correlated with soil clay content. Sorption increased in the order: phosphate $<$ sodium cacodylate $<$ DSMA $\simeq$ arsenate. A rapid ion-exchange clay surface-sorption process will apparently immobilize most of the arsenic reaching clay soil as DSMA or arsenate; somewhat less adsorption occurs with cacodylate. Arsenate or organoarsenical dissipation from agricultural fields by solubilization should be low.

This work summarized here has been conducted under CRIS Work Units 7402-14760-001 (approved), 7402-14760-002 (approved) and 7402-14760-003 (pending).

Publications:

Savage, K. E. Adsorption and degradation of chlorbromuron in soil. Weed Sci. 21:416-419. 1973.

Savage, K. E. and R. D. Wauchope. Fluometuron adsorption-desorption equilibria in soil. Weed Sci. 22:106-110. 1974.

Savage, K. E. Persistence of six dinitroaniline herbicides in soil. Proceedings So. Weed Sci. Soc. 1974 (Abstr.)

Savage, K. E. Adsorption and mobility of metribuzin in soil. Abstracts Weed Sci. Soc. Amer. pp. 120-121 (Abstr.)

Wauchope, R. D. Fixation of arsenical herbicides, phosphate, and arsonate in alluvial soils. Proceedings So. Weed Sci. Soc. 1974 (Abstr.).

b. <u>Summary of Progress for Extramural Projects</u>:

0710-11-02 (CA) Phytotoxicity of MSMA Residues and Arsenic Content of Foods. W. L. Barrentine and C. R. Swanson.

Five crops consisting of potatoes, snap beans, cotton, soybeans and rice have been grown three seasons following a single soil incorporated application of monosodium methanearsonate (MSMA) at rates of 0, 20, 40, and 240 lb/A. The identity of all plots was maintained throughout the three seasons in order to monitor the arsenic level in crops and soils following the single application of MSMA.

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WORK REPORTING UNIT REPORT AND PLAN
FY 1974-FY 1975

1. <u>Research Activity</u>: Weed Control in Field Crops

2. <u>Responsible Scientist and Location</u>:

   Responsible Scientist: C. R. Swanson, Laboratory Chief

   Location: USDA, ARS
   Southern Weed Science Laboratory
   P. O. Box 225
   Stoneville, Mississippi 38776

3. <u>Contribution of WRU to Research Activity Objectives</u>:

   Research Activity by title only.

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4. Changes in Direction of Work from FY 1974 to FY 1975:

No changes planned.

5. Specific Objectives for FY 1975:

a. Weed Control in Agronomic Crops:

(1) To determine the comparative toxicity of glyphosate to soybeans and johnsongrass in laboratory, greenhouse and field research as affected by date of application, herbicide rate, method of application, environmental conditions (air temperature, soil moisture and relative humidity), and soybean cultivars.

(2) To determine the competitiveness of hemp sesbania and *Ipomoea* species to soybeans and to investigate new approaches toward controlling these weeds in soybeans.

(3) To determine residual control of rhizome johnsongrass in soybeans with dinitroaniline herbicides as affected by herbicide rate and soil type.

(4) To investigate under field conditions the use of activated charcoal to protect seedling cotton from selected preplant and preemergence herbicides; and improve and design equipment that will adequately handle charcoal on a field basis.

(5) Complete a 3-year study to determine the effect of preemergence application of chlorobromuron and linuron on growth and yield of soybeans when preceded by 0, 1, or 2 years of diuron or fluometuron on cotton; and monitor the rate of dissipation and downward movement of these compounds.

(6) To determine the utilization of selected soil nutrients by cotton and three annual broadleaf weed species as influenced by level and time of nitrogen application.

(7) To investigate new or different control techniques on four malvaceous weed species, study their morphological development in a field environment, and evaluate their competitive ability with cotton.

(8) Continue studies on the control and comparative morphological development of three *Ipomoea* species found in cotton.

(9) Continue cooperative field work on the control of *Cyprus rotundus* L. (purple nutsedge) with *Bactra verutana*.

(10) To complete the field establishment of a weed seed burial study dealing with the seed longevity of 20 selected species found in the southern United States and initiate evaluation of recovered seed.

(11) To continue a 5-year investigation of the changes or ecological shifts in weed species, populations, and densities as affected by time and intensity of weed control procedures in cotton, corn, soybeans, and sorghum.

(12) To continue investigations of the physiological and ecological life history of *Echinochloa colonum* (L.) (junglerice).

(13) To determine whether sweet sorghum grown in rotation with soybean will be injured by residues of trifluralin applied at the 2X rate to control certain hard-to-kill weeds during the years soybeans are grown.

(14) To evaluate the inherent tolerance of several sweet sorghum cultivars to the herbicide, propazine, under field conditions.

(15) To investigate the effect on growth and development of partial and complete removal of cotyledons and various leaves of *Xanthium pensylvanicum* Wallr., *Ipomoea purpurea* (L.) Roth, and *Sesbania exaltata* (Raf.) Cory.

b. Biological Weed Control:

(1) To survey and determine the plant pathogen and insect natural enemies, or biological suppressants, that are present and attacking the weeds of the Midsouth.

(2) To determine the impact, or amount of damage, that the various biological suppressants have on their weedy host plants and to evaluate their potential use as biological control agents.

(3) To manage and manipulate the population of a native moth, *Bactra verutana*, in an attempt to suppress or control purple nutsedge, *Cyperus rotundus*.

(4) To follow up and complete previous studies on the feasibility of introducing from western Europe the rust, *Uromyces rumicis*, to control curly dock, *Rumex crispus*.

(5) To emulate the success in Australia, where the proper race of the rust, *Puccinia chondrillina*, controlled their ecotype of the Eurasian skeletonweed, *Chondrilla juncea*. Various races of the rust will have to be tested against the U.S. ecotypes of skeletonweed before success can be assured.

6. <u>Plan of Work for FY 1975</u>:

a. <u>Weed Control in Agronomic Crops</u>:

The laboratory, greenhouse, and field studies will be arranged in one of the standard statistical designs with at least three replications or more when it appears there will be wide variation in the data to be collected. The quantitative data will be analyzed and submitted to Duncan's multiple range test at the 1 or 5 percent level of confidence.

In the laboratory and greenhouse work standard analytical methods will be employed to measure nutrient and/or herbicide levels in both plant and soil samples. In the herbicide translocation studies, both liquid scintillation and autoradiographic techniques will be utilized to study movement of newer herbicides in plants. In studying the anatomy of individual weed species, standard microtechniques will be followed.

In the field studies, standard cropping procedures will be followed, except where the study calls for a change in practices. Replicated units of approximately 14 by 50 feet will be utilized for individual treatments. The crop seeds will be obtained commercially, and the weed seeds will be collected by hand or cleaned from several agronomic crops grown in the southern United States. The herbicides will be applied with plot tractor sprayers in 20 gallons of water per acre, and, if required, incorporated with a tandem disk. Both visual and quantitative data will be collected on both the weed species and crop being studied.

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b. Biological Weed Control:

Surveys will be made for any natural enemies, particularly insects, mites, and plant pathogens, that are feeding on selected weeds. The surveys will be made periodically in order to detect organisms that attack at different times of the year. The types of feeding and resulting damage will be noted and specimens collected for identification. The most promising natural enemies will be selected for detailed studies to determine their potential as biological control agents.

The most promising natural enemies will be concentrated upon in order to gain an estimate of the amount of damage inflicted, such as percentages of seed destroyed, leaf surface consumed, and stems weakened or killed. The kinds, numbers, and severity of any parasites, predators, or diseases that may be attacking the biological control agents will be determined. Paired samples from (1) croplands on which pesticides are in use and (2) nonagricultural areas will be made in efforts to determine any possible effects that pesticides may be having on each natural enemy. The most promising species will be studied in replicated trials under controlled conditions.

Continue the laboratory culture of the nutsedge moth so that large numbers of moths will be available for early-season release on purple nutsedge. The soil will be fumigated and 10 tubers planted per plot. The plots will be caged and three levels of moths introduced onto the shoots at an early growth stage (1-2" tall). Zero, 2 pairs, and 10 pairs of moths will be used. There will be four replications in randomized plots so that the results can be statistically analyzed.

There is need to fill in further on the ecology and biogeographical distribution of the insects of *Sida* and other malvaceous weeds. In the case of those insects confined to the southern portions of the ranges of their weed hosts, more data is needed to ascertain seasonal distribution and the dynamics of the apparent advance in range that occurs each year. There is need to investigate in the field indigenous *Sida elliotii* and its insect fauna in Tennessee, Alabama and Florida. This plant seems to be a northern allopatric form of *S. lindheimeri* of south Texas (south of Galveston Bay).

Similarly, but less urgently, there is need to investigate the ecology of the more northern *S. hermaphodita* and its insect fauna in Virginia, Pennsylvania, and Ohio.

There is further need to study *S. spinosa* and *S. rhombifolia* in Mexico, Central America, as well as southern South America. A hemisphere-wide understanding of the biogeography of this weed will pave the way for intelligent selection of bio-control agents that will merit intensive manipulative studies.

Preliminary studies in herbaria are necessary before any field work is done outside the continental United States.

The rust on curly dock in Europe will be studied. Techniques will be developed in order to germinate the teleospores. When teleospores are available, they will be tested against plants related to the known teleospore host, *Ranunculus ficaria*. Also, selected economic plants will be included so that the safety of all stages of the rust may be determined with a view of introducing it into the United States.

A number of races of the rust, *Puccinia chondrillina*, will be tested against the skeletonweed ecotypes found in the United States. When virulent strains are found, they will be tested against plants related to skeletonweed and against selected economic plants with a view to introducing the proper strains of the skeletonweed rust into the United States.

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10. <u>Progress in FY 1974</u>:

a. <u>WRU Summary for Intramural Research</u>:

(1) <u>Weed Control in Agronomic Crops</u>

(a) Weed Control in Soybeans

Foliar applications of glyphosate at 0.5 to 1.5 lb/A continued to provide excellent control of johnsongrass in soybeans regardless of stage of growth. Glyphosate continues to be the most toxic foliar-applied herbicide evaluated for johnsongrass control at Stoneville. Over-the-top and directed applications of glyphosate result in erratic soybean injury, but applications of the herbicide in a recirculating sprayer resulted in selective control of johnsongrass and many other weeds with glyphosate in soybeans. In addition to this spray system reducing toxicity of the herbicide to soybeans, treatments were highly economical because the recirculating sprayer recollects 50 to 90% of the original spray solution for reusage. Adverse environmental conditions consisting of low air temperatures, low soil moisture, and high relative humidity greatly increases glyphosate toxicity to soybeans. Existing soybean cultivars are susceptible to glyphosate, but several new soybean strains were found that exhibit much greater tolerance to glyphosate in cooperative research with Dr. E. E. Hartwig. Two new dinitroaniline herbicides, profluralin and butralin, appear equal to, or more effective than, the more established trifluralin in providing control of johnsongrass from rhizome and seed when applied at twice the normal use rate in soybeans. Research to date suggests that usage of 2X rates of dinitroanilines, in addition to applications of glyphosate with the recirculating sprayer, should largely eliminate johnsongrass as a major weed problem in soybeans when these practices are used in conjunction. Combination treatments of metribuzin applied preemergence and bentazon applied postemergence continued to provide cocklebur control in soybeans far superior to that available with any other practice or series of practices.

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(b) Weed Competition in Agronomic Crops

A 3-year competition study between cotton and various weeds showed weeds located within cotton rows to be far more injurious in terms of yield than weeds located between the cotton rows. Cotton left weed-free yielded approximately twice as much as cotton having weeds between the rows. Nitrogen level studies showed that highest cotton yields were obtained in plots receiving 200 lb/A of nitrogen. The weeds responded to nitrogen more vigorously than did cotton. The principal weeds were pigweed, crabgrass, crowfootgrass, velvetleaf, sida, johnsongrass, and morningglory.

Greenhouse studies over a 3-year period showed that as the number of cockleburs (*Xanthium pensylvanicum*) in soybeans increase, both the fresh and dry weight of soybeans decrease. Additional studies showed that if cotton has a head start on *Sida spinosa*, the cotton will be more vigorous. The greater the number of days that cotton can remain free of *Sida* the better chance the cotton plant has to be strong and healthy.

(c) Weed Control in Cotton

Full-season competition of the four velvetleaf or prickly sida plants/12 m of crop row resulted in a significant seed cotton yield reduction. Eight spurred anoda plants were required to reduce yields significantly, but 64 Venice mallow plants did not reduce yields. Seed cotton yields were not reduced by prickly sida, spurred anoda or Venice mallow at any weed density when competition occurred from 6 weeks after planting until harvest, but 16 or more velvetleaf plants/12 m of crop row resulted in a yield reduction.

Early-season visual soybean injury occurred when fluometuron or diuron at 5.04 or 3.36 kg/ha was applied to cotton in 1972 and planted to soybeans in 1973. Significantly greater soybean injury occurred where linuron or chlorbromuron was applied over the high 1972 rate of fluometuron or diuron. An exception was where chlorbromuron applied over diuron was not phytotoxic to the soybeans. Total seed cotton and soybean yields

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were not significantly reduced by any treatment combination, but the percent first harvest of cotton was reduced by all cotton herbicide treatments.

A hydraulic-operated sampler was designed and constructed for taking soil samples in row crops. The sampler is tractor mounted with a 3-point hitch, and the lateral probe mobility allows sample collection across two crop rows (combined features not commercially available).

A one-row planter was designed and built that would place charcoal in a 3- by 4-inch spot over each cotton hill. Based on seed cotton yield, protection of cotton from diuron with charcoal varied according to mode of charcoal application. In general with an increase in charcoal rate there was increased protection, but there were several exceptions since a charcoal-herbicide interaction occurred.

Growth reduction 18 days after nutsedge emergence was greater when *Bactra verutana* larvae were released on 3- or 10-day old shoots than on shoots 15 days old. Two or five larvae per shoot were equal in reducing growth. Four post-emergence applications of naptalan or TIBA did not adversely affect the development of a natural field infestation of *Bactra verutana*.

Comparative growth of tall, ivyleaf and white morningglories after 8 weeks of growth showed that white and ivyleaf had significantly more leaves than tall. The order of above-ground dry matter production was white $>$ ivyleaf $>$ tall morningglory. At 8 weeks there was no difference in the number of primary runners, but white morningglory had significantly more secondary runners than ivyleaf or tall morningglory. The order of tertiary runner production was white $>$ ivyleaf $>$ tall morningglory. The comparative susceptibility of these three species to several herbicides was studied.

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(d) Weed Control in Corn and Sorghum:

In the first year of a 3-year study of the residual effects of herbicides on sweet sorghum grown in rotation with soybean, we applied propazine as a preemergence treatment and atrazin as a postemergence over-the-top treatment to 25-cm-tall sweet sorghum at rates of 2.24 kg/ha for control of weeds in the crop. Trifluralin was applied as preplant incorporated treatments at rates of 0.56 and 1.12 kg/ha for control of weeds in soybean. One shallow sweep cultivation was made following the herbicide treatments before the remaining weeds were 5 cm tall. *Digitaria sanguinalis* (L.) Scop., *Ipomoea* spp., *Amaranthus* spp., and *Mollugo verticillata* L. were controlled effectively by the treatments. None of the treatments caused significant reductions in yield. Six months after application of the herbicides we detected no residues toxic to sweet sorghum grown for three weeks in the greenhouse on soil samples collected from three layer depths of 0 to 10, 10 to 20, and 20 to 30 cm.

In greenhouse investigations of the tolerance of sweet sorghum cultivars to propazine applied preemergence at six rates of 8, 4, 2, 1, 0.5 and 0.24 kg/ha, we found great differences in tolerance among the 50 cultivars examined. Most of the relatively tolerant lines originated in Belgium Congo, Africa. No other herbicide is registered for use in sweet sorghum.

We obtained base-line information on the populations of weeds and weed seed present in plots used to grow cotton, corn, soybean and sorghum during FY 1974. During the next 5 years we will continue the study to determine changes or ecological shifts in weed species, populations and densities with time and intensity of weed control procedures in the four crops.

(2) Biological Weed Control:

(a) Biological Control of Humid Pasture Weeds

A total of 21 species of insects was reared from purple and/or yellow nutsedge. These include one thrips, one aphid, one mealybug, seven

leafhoppers, seven moths, one flea beetle, and three weevils. Of these, only the moth, *Bactra verutana*, causes significant damage and is known to have a restricted range of host plants. However, although nutsedge begins to grow in early April, it is not until early August that *Bactra* larvae cause general plant damage. Parasitism, cannibalistic larvae, and low winter temperatures result in small numbers of living larvae and pupae that overwinter. Thus there is a slow build-up in numbers throughout the spring. In efforts to determine the value of early-season releases, greenhouse tests were used. These showed that two or five larvae confined with young shoots for 30 days caused significantly more damage than one larva. In two caged field plot trials, where the larvae were free to disperse, there were no significant differences in damage caused by the feeding of 1, 2, 5, or 10 larvae per shoot when applied while shoots were 1-2" tall. However, the damage caused by two or five larvae applied when the shoots were 1-2" tall (3 days of age) was significantly greater than when two or five larvae were applied when the shoots were 3-4" tall (6-8 days old) or 5-7" tall (12-15 days of age). In conclusion, where the larvae are free to disperse to undamaged shoots, as in nature or in our cages, the number of larvae per shoot are of less importance than the time of infestation. Feeding by *Bactra* larvae can cause significant damage if it begins early when the shoots are small and young. For example, in the two field trials under cages, started in late May and late July, reductions in growth of 35% to 57% were measured for numbers of undamaged shoots, dry weight of aerial shoots, weight of basal bulbs, and, for the July test only, the weight of tubers produced.

(b) Surveys and Evaluations of Insects for Biological Control of Weeds in Crops (approval pending)

Sida spinosa, as an ecotypic form, occurs sparsely in disturbed soil as well as in natural vegetation formations in south Texas. It was not found to be a weed problem in the fields that were observed in that region, *Amaranthus* being the conspicuous weed problem generally. Climatic effects

probably are largely responsible for this contrast with the fields in the Mississippi alluvial plain. But suppressive insects could be involved to some extent.

About 25 species of insects have been found to attack *S. spinosa*. Of these, six may be considered to be specialized and of possible importance. One of these, a fruit-infesting *Conotrachelis* weevil, ranges from the Rio Grande to southern Illinois. In the vicinity of the Mississippi alluvial plain, this insect is restricted to *S. spinosa*; but in the fall a minor invasion develops in *S. rhombifolia*. Infestations of 5 to 10% are common in *S. spinosa* and late in the season they may attain as much as 28%.

The remaining five species attack indigenous *Abutilon* spp. as well as various species of *Sida*. A leaf-mining hispid beetle, a defoliating skipper butterfly, and a seed-destroying corizid bug have not been found to occur north of Grand Gulf (south of Vicksburg). A lepidopterous fruit worm and a flower bud-infesting *Anthonomus* weevil do not penetrate inland from the Gulf Coast of Louisiana.

In the base of the leaf-mining hispid beetle evidence indicates that the insect crosses the Mississippi River late in the season but then is presumable killed back each winter. Also, the biogeographical picture that is unfolding indicates that *S. spinosa* is possibly indigenous to south Texas and may have extended its range northward as man's agriculture opened up and largely destroyed much of the natural vegetation cover of middle North America. *S. spinosa* reaches its northern limit in southern Illinois and Indiana while *S. rhombifolia* reaches its northern limit near Pine Bluff, Arkansas, and south of Tennessee. Both *S. spinosa* and *S. rhombifolia* are widespread in the Americas south of the United States.

No important specialized insects of velvetleaf, spurred anoda, or Venice mallow have been found thus far. This result may be consistent with the absence of sufficiently related native plants in the region of study.

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(c) Plant Pathogens as Biological Agents for the Control of Weeds in Crops (approval pending)

Survey trips were made in Mississippi, Arkansas, Louisiana, and Texas to search for candidate pathogens for biological control. Fungi were found on morningglory and various other weedy plants. Of the pathogens found, three indigenous ones showed the most promise. Two are rusts on *Ipomoea* spp. They are *Coleosporum ipomoea* and *Albugo candida*. On *Cyperus esculentus*, a rust which is probably *Puccinia canaliculata*, was cultured in the greenhouse. Techniques to increase these rusts for use as biological control agents for these weeds was studied.

(3) Publications:

McWhorter, C. G. 1973. Johnsongrass as a weed. USDA Farmers Bul. No. 1537. 18 p.

Wills, G. D. and C. G. McWhorter. 1974. Translocation of bentazon in 'Hill' and 'Hurrelbrink' soybeans as affected by temperature. Proc. S. Weed Sci. Soc. 27: (In Press).

McWhorter, C. G. 1974. Effect of environment on toxicity of glyphosate to soybeans and johnsongrass. Abstracts Weed Sci. Soc. Amer., pages 118-119.

McWhorter, C. G. 1974. Johnsongrass control in soybeans with trifluralin and nitralin. Weed Sci. 22:111-115.

McWhorter, C. G. 1974. Water-soluble carbohydrates in johnsongrass. Weed Sci. 22:158-163.

Robinson, E. L. 1973. Weed control in cotton with emulsified oils and herbicidal naphtha. Weed Sci. 21(5):402-404.

Robinson, E. L., J. R. Williford, and O. B. Wooten. 1974. Effect of incorporation of diuron and fluometuron on weed control and cotton injury. Abstr. Weed Sci. Soc. Amer., p. 96.

Williford, J. R., E. B. Williamson, and E. L. Robinson. 1973. Effect of bed height, rate of nitralin application, and method of soil incorporation on cotton growth and weed control. Proc. Amer. Soc. Engineers, 19 p.

Chandler, J. M. and J. E. Dale. 1974. Comparative growth of four malvaceous species. Pro. S. Weed Sci. Soc. 27: In press.

Chandler, J. M. and K. E. Savage. 1974. Construction and utilization of a versatile tractor-mounted soil sampler. Abstract, 1974 Meeting of Weed Sci. Soc. Amer., p. 60.

Frick, K. E. and J. M. Chandler. 1974. Culture of early release of *Bactra verutana*, a biological agent for purple nutsedge control. Abstracts, 1974 Meeting of Weed Sci. Soc. Amer., pages 66-67.

Frick, K. E. 1974. Current status of biological weed control projects in the United States. Abstracts, Weed Sci. Soc. Amer., pages 67-68.

(4) Invitational Papers and Technical Presentations:

McWhorter, C. G. 1974. No-till or minimum tillage in crop production in the United States. Invitational paper now in preparation to be presented before the Soil Con. Soc. of America (SCSA), Georgia Section in Rome, GA on June 21, 1974 and to be published in a monograph by the SCSA.

McWhorter, C. G. 1973. The effect of environment on the toxicity of glyphosate to soybeans and johnsongrass. Presented at the Midsouth Research Seminar in Corpus Christi, Texas, Oct. 25, 1973.

McWhorter, C. G. 1974. A systems approach to weed control in soybeans. Presented before the Mississippi Soybean Association, Mississippi State, MS, Feb. 1, 1974.

McWhorter, C. G. 1974. New herbicides for weed control in soybeans. Presented before the 1st Delta-Wide Pesticide Clinic, Cleveland, MS, Feb. 4 and 5, 1974.

McWhorter, C. G. 1974. The dinitroaniline herbicides. Presented before the 3rd Annual Pest Management Workshop, Greenville, MS, March 5, 6, 7, 1974.

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Chandler, J. M. 1974. Agronomic Weed Control Research at the Southern Weed Science Laboratory. Presented to Plant Pathology and Weed Science Department Seminar, Mississippi State University, March 6, 1974.

Frick, K. E. 1974. By invitation, presented a paper on the current status of biological weed control projects in the United States at the Weed Science Society of America, Las Vegas, Nevada, Feb., 1974.

b. <u>Summary of Progress for Extramural Projects:</u>

None

SCS-ARS WORKSHOP
Fort Worth, Texas
April 16-18, 1974

R. D. Wenberg - Recorder

April 17, 1974, p.m.

W. L. Vaught

1. Discussed the SCS organization relative to ARS liason.

2. Explained the manner in which TSC personnel assist the State Conservationists.

Oklahoma-Texas Area - Bill Ree presiding

Don DeCoursey, Southern Great Plains Research Center Leader

1. Discussed infrared photography shows significant watershed characterists

    1. Gullies
    2. High evapo-transpiration areas
    3. General soils relationships
    4. Potential runoff CN interpretations

2. Detention structure water loss discussion

    A. Conservation pool below dam discussion as an alternative to sediment pools.

    B. Aerial rainfall reduction relative to D. A. is shown to be much more significant than the factors presently used by SCS.

    C. No chance of rainfall relative to AMC 1, 2, 3 was discussed

    D. Detention structures in salinity areas need to be proportioned to consider adequate flushing.

Ron Menzel - Durant, Oklahoma

Pictures of laboratory area were shown

Study of Euthrophication and pesticide presistance was explained.

Distributed WRU reports. (copy attached)

Bill Ree - Hydraulic Structures

Research is necessary to analyze practical and economical designs. (notes attached)

Pat McIlvain - Woodward, Oklahoma

Improved range management systems (see handout attached)

Bill Fryrear

1. West Texas drought problems

2. Influence of wind erosion

3. Wind erosion tests (handout attached)

Use of Cotton Burs

Depressing pepper plants to minimize wind erosion hazards in:

a. narrow furrow
b. z furrow
c. holes

Herbicide studies discussed

Bob Stewart - Bushland Texas

(Brochure Handout attached)

(List of Publications)

Slides

Ground water recharge

Minimum tillage

Double crop irrigated land to maximum use of irrigation water.

Dryland farming with manure fertilization at various rates

10-240 ton/ acre.

GENERAL DISCUSSION OF COOPERATIVE EFFORTS

The dominant topics discussed were related to information exchange between ARS and SCS and to increasing SCS's capability for estimating the environmental impact of their programs.

Both SCS and ARS comments regarding information exchange roughly breaks into three groups.

The first is that no vehicle exists for the routine transmission of data and concepts from ARS to SCS except through scientific journals. Several SCS people stated a preference for an annual report or equivalent that summarizes contemporary ARS research and data. Several ARS station directors stated that they are presently issuing or plan to issue a periodic research report in some modified form for the use of SCS and similar groups. One suggestion was to routinely submit or appropriately distribute papers upon approval by ARS administration, thereby eliminating pre-publication delays.

The second was that better communication and contacts are needed at the field levels of both agencies. Specifically, the use of direct communication, consultation trips, workshops, and even short-term work-study programs to develop solutions for specific SCS needs were suggested. One point was that in order to make a concept operational or to adapt a technique for specific use, the principal personnel involved in application should be able to work with the developer. This would insure that the technique or concept would be used to its fullest advantage and, similarly, provide feedback on applications and related problems to the researcher.

The third was that ARS needs feedback from SCS on the applicability of ARS research and the specific SCS needs on a continuing updated basis. Periodic workshops and better communications were suggested to establish this feedback.

The discussion of input needs for impact statements were varied. Generally, the SCS comments regarding ARS input related to two suggestions. Firstly, SCS requested that ARS consider additional data collection on present ARS networks where possible to obtain concepts or data to evaluate the impact of SCS programs on biotic phases, water quality, etc. They stated a concern for being able to ascertain pollutant movement, changes in species densities or wildlife populations. Much of what they requested could be determined by periodic survey. Secondly, SCS suggested that ARS become sufficiently involved with the mechanics of constructing impact statements to acquaint themselves with the process. This would better equip ARS to scan their present research output and, if needed, modify studies to include additional features necessary to answer SCS's questions.

Presented by Donn G. DeCoursey, Research Leader, Southern Great Plains Research Watershed, ARS, Chickasha, Oklahoma, at the ARS-SCS Workshop, April 16-18, 1974, Fort Worth, Texas.

WATERSHED AREAS

WATERSHED	ACRES	SQUARE MILES
100	2,339,800	3,656
110	25,020	39.1
111	16,634	25.99
121	131,780	205.9
131	25,680	40.1
141	47,230	73.8
200	2,612,500	4,082
311	15,208	23.76
400	2,725,800	4,259
411	33,300	52.0
500	2,768,000	4,325.5
511	38,020	59.4
512	22,530	35.2
513	12,314	19.24
522	132,990	207.8
600	3,011,800	4,706
611	4,845	7.57
612	563	.88
621	21,310	33.3
700	3,061,120	4,783
514	7,225.6	11.29
5141	4,064	6.35
5142	360.3	.563
5143	485.8	.759
5144	1,456.6	2.276
5145	252.8	.395
5146	761.6	1.190
R-1	17.8	
R-2	24.1	
R-3	25.8	
R-4	18.1	
R-5	23.7	
R-6	27.2	
R-7	19.2	
R-8	18.5	
C-1	17.8	
C-2	32.5	
C-3	44.3	
C-4	29.9	
C-5	12.8	
C-6	13.0	
C-7	26.5	
C-8	27.3	
T-1	41.5	
T-2	34.8	
T-3	30.4	

LEGEND

- STUDY REACH BOUNDARY
- WATERSHED BOUNDARIES
- WATERWAYS
- STREAM GAGING STATION - FIELD RATED & WATERSHED NUMBERS (121)
- STREAM GAGING STATION (WEIR) FIELD RATED
- CITIES & TOWNS
- ALL WEATHER ROADS & HIGHWAYS (17, 81)
- RAIN GAGE STATION

NOTE:

1. WATERSHED 141 — STAFF GAGE ON LAKE CHICKASHA
2. WATERSHEDS R-1, R-2, R-3 & R-4
3. WATERSHEDS R-5, R-6, R-7 & R-8
4. WATERSHEDS C-1, C-3, C-4, C-5, C-6, C-7 & C-8

SEE INDIVIDUAL WATERSHED MAPS FOR EXACT WATERSHED BOUNDARIES & AREAS

WASHITA RIVER EXPERIMENTAL WATERSHED

CHICKASHA, OKLAHOMA

COMPOSITE MAP

SHOWING SUB-WATERSHEDS

Research at the Southern Great Plains Research Watershed of Interest to SCS

The Southern Great Plains Research Watershed is one of a few ARS Centers devoted almost strictly to hydrologic research. The study area is the central portion of the Washita River basin in south central Oklahoma (see attached map).

Objectives of the research are to: (1) determine the effects of regulated flows resulting from combined land treatment and structural measures in tributary watersheds upon flood flows, annual and seasonal water yields, groundwater levels, and stream channel stability of the main channel of the river; (2) determine the amount, character, and movement of pollutants such as sediment, salt, and plant nutrients in the river system and develop possible procedures for water quality improvement; (3) analyze and interpret available data to determine what might have been the effect along the mainstem with alternative treatment programs in the tributary watersheds; (4) develop concepts and procedures for use in other river basins; and (5) develop conservation practices for better overall watershed performance.

In order to achieve these objectives, 1,130 square miles in the central part of the Washita River Basin have been instrumented to collect basic hydrological and water quality data. In 1961 when instrumentation started, this central part of the basin had very little watershed development; but by 1973 several tributaries in the study reach were being developed. Within the study reach, hydrologic data are collected at about 50 gaging stations ranging from 1.48 acres to 4,783 square miles. Four of these stations are on the Washita River, 12 of the stations are on tributaries to the Washita River, 8 stations fully subdivide one of the major tributaries, and 22 stations are unit source watersheds within the study area. Precipitation records from about 230 recording rain gages support the runoff measuring stations. Sediment concentration data are collected at 40 of the stations by either an automatic pumping sampler or by hand. Water level records are also collected at six floodwater retarding structures with complete ET data collection at one site. Groundwater level records at 290 sites are monitored and soil moisture records are collected at all unit source watersheds. Salinity records are maintained at nine of the gaging stations. In cooperation with the Water Quality Management Laboratory at Durant, nutrient studies are being carried out on 11 of the unit source watersheds and some of the tributary stations.

Following are brief summaries of some of the major research efforts of interest to the Soil Conservation Service:

Remote Sensing

Encouraging results have been obtained in relating differences between the red and green band sensor response from the Earth Resources Technology Satellite (ERTS) multispectral scanner to SCS curve numbers. The relationship was developed on a set of 10 watersheds in the Chickasha area. Reasonably good predictions of runoff curve numbers were obtained on an alternative set of 10 watersheds using the relationship developed on the first set of watersheds. Further testing of the prediction scheme on flood detention structures located in the drainage area of Sugar Creek

indicates that some predictions were not significantly improved, however all the predictions were nearer to measured curve numbers than were the original design curve numbers.

Somewhat similar results have been obtained from passive microwave data. These are being actively pursued at the present time because the characteristics of passive microwave response would indicate that it may have more potential than other sensing systems.

Effect of Structures on Flow

Study of the base flow records of Sandstone, Rush, and Tonkawa Creeks indicates there has been no increase in base flow following installation of floodwater retarding structures. Base flow duration curves of the treated and adjacent untreated watersheds were compared with results that disagree with Kennon's[1/] conclusions that the structures on Sandstone Creek had caused an increase in base flow beginning 6 years after installation of the structures.

Records collected at five structures on Sugar and Winter Creeks support the Sauer-Masch relation between inflow to and outflow from structures in Texas and Oklahoma. An alternative structural design for sites where there are no plans for beneficial use of the sediment pool water has been suggested[2/]. The proposal would alleviate problems including downstream water yield reduction, erosion of dams through wave action, and salt accumulation, which are associated with permanent storage of water in the conventional sediment pools west of the 98th meridian.

Depth-Area-Duration Model

A depth-area-duration model of storm rainfall developed using 10 years of rainfall data collected from the network at Chickasha is being tested and compared against the area-oriented model developed by the Weather Service and now being used by the SCS. Major differences between the two models are: (1) the ARS model is based on storm center rainfall while the Weather Service model is based on maximum average annual amounts, and (2) the ARS model represents the average areal reduction based on storm distributions over a given area while the NWS model represents a composite of several storms during a 1-year period. Results show that the reduction of point/areal rainfall by the NWS method is approximately 80 percent at 400 miles, and is not affected by the network gage density.

1/ Kennon, F. W., Hydrologic Effects of Small Reservoirs in Sandstone Creek Watershed, Geological Survey Water Supply Paper 1839-C. 1966.

2/ Schoof, R. R., Naney, J. W., and Boxley, W. M. A Design for Conserving Water at Floodwater-Retarding Structures. Proceedings Watersheds in Transition Symposium, American Water Resources Association, 1972.

Stochastic Generation of Sequential Rainfall Events

A four-stage model for the generation of sequential rainfall events, including pattern shape, size, and orientation, has been developed. The four steps include the generation of: (1) the wet-dry day sequence, (2) the location of the pattern center within a given area, (3) the maximum pattern amount, and (4) the mean, standard deviation and pattern of rainfall.

Joint Probabilities of Antecedent Soil Moisture and Rainfall

A study has been initiated to determine the probability of occurrence of rainfall at given antecedent moisture levels similar to those conditions used by the SCS in the selection of runoff curve numbers. Results of the analysis of the rainfall on watersheds at Chickasha show that about 80 percent of the time, rainfall occurs at condition I, 8 percent of the time at condition II, and 12 percent of the time at condition III. These values represent the percent of rainfall that occurs at these levels. More information is needed on the probability of receiving a given amount of rainfall on a given antecedent moisture level.

Salinity-Impoundment Interactions

Impoundment of surface waters within the Southern Great Plains can cause the salinization of these waters. Much of this area is characterized by saline geologic deposits, an increasing emphasis on usable water supplies, and a high evaporation rate. These characteristics emphasize the need for controlling the salinity increase due to impoundment.

First, most floodwater-retarding structures built by the SCS in this area contain sediment pools designed to accommodate the accumulated sediment inflow for either 25, 50, or 100 years. These pools contain water until they fill with sediment. In cases where the design size predicted according to sediment inflow greatly exceeds the design size predicted according to stream inflow, salinization due to impoundment will result. This is largely caused by evaporational and evapotranspirational processes. To avoid salinization of impounded waters, predictions of sediment and water inflow over the life of the structure should be compared to test for overdesign with regard to salinity. Where projected sediment inflow exceeds considerably the projected water inflow, the sediment pool design should be reduced correspondingly by installation of sediment control practices directly to upstream source areas. This could involve land treatment.

Secondly, the characteristics of the multiple impoundment system can alter salinization patterns of surface water over a watershed. Here, questions of water quality goals must be answered, such as, "Should the salinity of either impounded or outflow waters be optimized?" Reservoir routing techniques that superimpose alternative impoundment systems on the geology, and input local evaporational and runoff data into these systems can be used to select among the alternative systems that can be realistically considered for a tributary watershed. This approach may be useful for objectively estimating impact for constructing impact statements.

Hydrologic Modeling

SCS needs information about the downstream impact of floodwater retarding structure programs on peak flow, runoff volume, and flow duration. The approach being used by the Southern Great Plains Research Center to meet this need is continuous simulation of streamflow using mathematical hydrologic models. A composite model under development at the research center is to be bompared with existing models, such as the Stanford Model. Tributary watershed hydrographs will be predicted and then routed downstream for analysis. The flood-routing procedures must account for differences in depletion of streamflow as a function of stage in order to answer questions about magnitude of downstream reductions in flow. Floodwater retarding structures are to be conceptually represented. Questions have been raised about the ability of rainfall-runoff models which do not account for farm ponds, to adequately describe the runoff hydrograph from a watershed with significant area behind ponds. Therefore, rainfall-runoff models will be tested to see if small reservoirs need to be represented; if so, this would accomplish the modeling of floodwater retarding structures. The rainfall input to the model are to include nonhistoric sequences to help detect any bias due to using a particular historic sequence. Work is underway to generate rainfall patterns over an area and test the suitability of method for input to a model.

Sediment Yield Reduction on Watersheds Treated with Floodwater-Retarding Structures

After four Washita River tributary watersheds were treated with structures, sediment-yield reductions ranged from 40 to 60 percent. A larger initial reduction was observed while the reservoirs were filling. On Winter Creek there was an additional reduction because channel bank erosion was halted. However, channel work on the Sugar Creek channel caused tremendous increases in the load in the Washita River due to bank erosion.

Unmeasured Sediment Load

Where sediment transport is computed by taking sediment samples of the flow, the bottom few tenths of a foot is not sampled and the sediment transported here is commonly referred to as unmeasured load. Only two computational methods were available to compute this load for the Washita River and these methods usually produced considerably different loads. For clarification, considerable sediment and velocity distribution data were collected for a few flows at Washita River stations. This work showed that the often used, theoretical, sediment-concentration distribution equation was valid, but that the logarithmic vertical velocity equation poorly predicted velocities. A new and unmeasured load procedure was developed that can be used to check existing procedures. It can also be used to develop curves at gaging sites where other methods do not apply such as where the channel bottom is strewn with rip-rap.

Gully Erosion

Data from a research watershed indicates that sediment yield from a gullied area occupying 1 percent of the watershed contributes 265 tons/acre sediment and supplies approximately 50 percent of the sediment from the entire watershed.

Groundwater along Channels

The groundwater levels in lower Sugar Creek prior to channel dredging were at some points less than 1 foot below the ground surface and made many acres of the Sugar Creek watershed unuseable for either farming or ranching purposes. Many areas of lower Sugar Creek were subject to repeated salt buildup as a result of near-surface evaporation of water from the water table. Since the channel improvement work, the groundwater levels along the new Sugar Creek channel have been dropping at the rate of about 2 feet per year and have stabilized at about 1 foot above the new channel bed. The new groundwater table along Sugar Creek is some 8 to 12 feet below ground surface near the channel, but has changed very little at distances beyond 1,000 feet.

Groundwater near Flood Detention Structures

A computer program has been developed to predict the groundwater level changes around flood detention reservoirs. The method is based on in-place permeability tests and groundwater levels prior to construction. The program can also be used to estimate the travel time of this water.

Nutrient Pollution and Land Use Management

Water quality records from seven cropland watersheds ranging in size from 13 to 44 acres and four rangeland watersheds ranging in size from 18 to 27 acres were analyzed for nutrient content. During the 18-month period of record, over 40 rainfall and runoff events from most of the watersheds were sampled. Average total nitrogen concentrations ranged from a high of 5.5 ppm from an irrigated cotton watershed to a low of 1.1 ppm from a rangeland watershed in good condition. The average total phosphorus concentration ranged from a high of 4.6 ppm from the irrigated cotton watershed to a low of 0.7 ppm from the rangeland watershed in good condition.

WRU NUMBER: 401-7320-14760

Work Reporting Unit Report and Plan
FY1974-FY1975

1. Research Activity: Control of pesticides in soil and water.

2. Responsible Scientist and Location:

Ronald G. Menzel, Location Leader
USDA, ARS
Water Quality Management Laboratory
Route 2, Box 322A
Durant, Oklahoma 74701

3. Contribution of WRU to Research Activity Objectives:

We will develop basic information on the behavior of pesticides in farm pond and small stream environments, especially as related to the movement of pesticides from agricultural land. Principles and concepts will be developed in the laboratory, and will then be tested in small ponds or watersheds. Research data will be obtained and coordinated from locations throughout the United States. Pond and watershed properties, as well as management practices, will be evaluated to minimize harmful consequences of pesticide uses in agriculture.

4. <u>Changes in Direction of Work from FY 1974 to FY 1975</u>:

No changes planned.

5. <u>Specific Objectives for FY 1975</u>:

a. Screen major groups of farm pond microorganisms for interactions with arsenical herbicides.

b. Determine distribution of organic and inorganic arsenic in pond microcosms.

c. Compare biological behavior of model research ponds with that of local farm ponds.

d. Improve the agricultural chemical transport model by introducing interflow parameters.

6. <u>Plan of Work for FY 1975</u>:

Fresh pond water will be placed in flasks with various concentrations of sodium arsenite or disodium methanearsonate. The survival of pond microorganisms will be determined by plate counts, and the added arsenicals will be monitored for losses, uptake, and transformation. Similar tests will be made with laboratory microcosms that contain pond water and sediments.

Arsenic analyses will support the studies on microbial interactions. Ion exchange resin methods will be tested for separating methylated arsenic compounds from inorganic forms.

Ten newly constructed model research ponds, each 20 feet in diameter and 9 feet deep, will be utilized. Bottom sediments will be Bowie sandy loam or San Saba clay, treated with superphosphate to achieve low, intermediate, and high dissolved phosphate levels. Inoculant from farm ponds will be added to establish aquatic populations. Diatom and plankton communities will be compared with those of farm ponds in preparation for future studies on the fate of arsenical herbicides as influenced by phosphate eutrophication. Temperature, light penetration, pH, dissolved oxygen, and concentrations of phosphorus and nitrogen compounds will be monitored.

The agricultural chemical transport model (ACTMO) will be improved by a suitable description of water flow paths. In collaboration with Dr. C. R. Amerman, ARS, Columbia, Missouri, a simplified description of two dimensional flow through soils

will be sought that is compatible with the submodels of ACTMO. Laboratory and small field plot studies will be conducted to verify the use of a dispersion factor to calculate concentrations of chemicals in runoff. The model will be tested using available data from a variety of chemicals and watersheds.

7. SMY for FY 1974 and FY 1975:

Scientist	Grade	Title	SMY FY1974	Est SMY FY 1975	Other RA's to Which Assigned FY1974	FY1975
Ronald G. Menzel	15	Soil Scientist	0.4	0.5	14830	14830
Maurice H. Frere	14	Soil Scientist	0.5	1.0	14830	
Victor L. Hauser	14	Agr. Engineer	0.5	0.0	14830	14830
Robert J. Davis	12	Microbiologist	1.0	1.0		
Oliver R. Lehman	11	Soil Scientist	0.4	0.5	14830	14830
Mutsuo Yamamoto[a/]	11	Chemist	0.0	1.0		
		Total	2.8	4.0		

a/ Promotion to GS-11 projected 7-1-74.

8. CRIS Work Units in WRU:

Number	Title	Termination Date	Percent of WRU Resources Allotted to each CRIS FY1974	FY1975
Intramural				
7320-14760-001	Release of adsorbed pesticides into water	*16Jun74	100	100
Extramural				
PK**- -001 (R.J. Davis)	Effect of different kinds and degrees of pollution on the aquatic organisms of West Pakistan	1Sep76	---	---

* To be revised.

Control of Pesticides in Soil and Water, Durant, Oklahoma

401-7320-14760

10. Progress in FY 1974

a. WRU Summary for Intramural Research:

Populations of bacteria, fungi, and algae have been surveyed in Bryan County farm ponds in preparation for studies of pesticide interactions with these organisms. Populations were similar in clear and turbid ponds, but the suspended solids in turbid ponds usually did not exceed 100 ppm. Numbers of aquatic fungi were lower in a 5 acre pond on calcareous clay soil than in two smaller ponds in a non-calcareous sandy loam soil area. Algae populations were usually small and highly diverse.

Responses of pond microorganisms to additions of arsenite, arsenate, disodium methane arsonic acid (DSMA) and cacodylic acid were studied in the laboratory at concentrations up to 100 ppm of arsenic. Many organisms, especially algae, were killed by the highest concentration, although bacterial numbers were not much affected by DSMA. The number of bacteria increased at arsenic concentrations of 0.1 to 1 ppm.

In pond microcosms to which sodium arsenite or DSMA had been added at concentrations up to 100 ppm of arsenic, half of the added arsenic disappeared from solution in 15 to 30 days. Disappearance continued at a slower rate, indicating the possibility of diffusion into deeper layers of sediment. Disappearance was similar for sodium arsenite and DSMA except at low concentrations (10 ppm), where less arsenic disappeared from DSMA solution. The forms of arsenic remaining in solution have not been determined.

In a cooperative study with the Southwestern Great Plains Research Center, Bushland, Texas, increased bacterial populations were found to depths of 18 feet beneath plots that received annual manure applications ranging from 10 to 240 tons per acre.

The comprehensive model of agricultural chemical transport (ACTMO) has been developed utilizing submodels on hydrology from Beltsville, Maryland, erosion from Morris, Minnesota, and chemistry from Durant. The model is designed for farm-size watersheds on which a limited number of soil and land use units can be defined. It has been tested with data from

five runoff events, involving two applications of carbofuran, near Coshocton, Ohio. Movement of carbofuran from the watershed was predicted reasonably well, but additional tests are needed to develop and evaluate the model.

Equations relating runoff to rainfall and moisture content in fallow soils were tested with data from Bushland, Texas, and Hays, Kansas. Runoff was predicted more accurately, especially with the data from Bushland, than with the accepted SCS runoff equation. To improve the prediction for Hays would require that drying characteristics be determined specifically for that soil.

Publications:

Frere, M. H. 1973. Adsorption and Transport of Agricultural Chemicals in Watersheds. Trans. Amer. Soc. Agric. Eng. 16:569-572, 577.

Presentation:

Frere, M. H. April 17-18, 1974. Seminar on "An Agricultural Chemical Transport Model" with the Department of Land Resource Science, University of Guelph, Ontario, Canada.

b. Summary of Progress for Extramural Projects:

No report is yet available for the project in West Pakistan. It was initiated September 1, 1973.

c. CRIS Work Unit Progress Report (Form AD-421):

Attached.

HYDRAULIC RESEARCH AT THE
WATER CONSERVATION STRUCTURES LABORATORY
For presentation at SCS-ARS Workshop
Fort Worth, Texas, April 17, 1974

by W. O. Ree

Hydraulic structures are needed to control floods, store water, mitigate pollution of streams, prevent erosion, control water levels, prevent stream degradation, protect stream banks, and to measure stream flow. Research is needed to develop adequate, safe, yet economic structures to do these jobs. This is the research we do at the Water Conservation Structures Laboratory, at Stillwater, Oklahoma.

A comparison of the performance of two gully control structures in Minnesota will illustrate how small differences in design can make a great difference in performance.

A straight drop spillway in the Bear Valley Watershed in Minnesota was subjected to a major flood. As a consequence the channel immediately below scoured to a depth threatening to undermine the drop spillway.

Another straight drop spillway in the Bear Valley Watershed of same size but of slightly different design was subjected to the same flood event and came through with the channel below undamaged. The spillway had done its job.

The differences between the two structures were the slightly different proportions and a different arrangement of blocks and sills on the aprons. The design of the second structure was based on tests by ARS at the SAF Hydraulic Laboratory in Minnesota. The costs of the two spillways were probably the same, but what a difference in performance!

I have shown but one type of structure. There are structures of other types of greater complexity and size. The trend in SCS is an increasing range in structure size from the small check dams and pipe spillways on farms to major multipurpose reservoirs costing in the millions. Some examples are:

1. The 106 foot high dam for flood control and water supply at Alma, Arkansas.
2. The chute spillway for the Cotile Reservoir near Hot Wells, Louisiana.
3. A 57 foot tall drop inlet on Lunice Creek, Site 10, West Virginia.

I could show many more examples, but I believe that those I have shown establish the fact that SCS is engaged in the design of major hydraulic works and needs hydraulic research to answer questions which arise.

Dollar-wise also the SCS is in big business. Over one billion dollars have been invested in structural measures supporting the watershed program. Yet not much more than 5% of the needed work has been done. So the total investment in hydraulic structures for the watershed program could ultimately exceed 20 billion dollars (at 1974 prices). Hydraulic research is needed to insure adequate, safe, and economic structures.

What has the Water Conservation Structures Laboratory done in support of the conservation programs of the U. S. Department of

Agriculture? I'll review our past work briefly.

The initial research was a study of grassed waterways. This work required a large sloping area and a large supply of water which we have at Lake Carl Blackwell near Stillwater, Oklahoma. Tests were run on various grasses to determine Mannings' n values and permissible velocities. The results of these studies were incorporated into the Handbook of Channel Design for Soil and Water Conservation.

We have also determined Mannings' n values for diversion terraces with various crops growing in them. Included in these studies were sorghum, cotton, and wheat.

Spatially varied flows have been studied intensively in a 400-foot long channel which can receive flow over its side for its full length.

Mats and mulches, including jute, paper mesh, and glass fiber have been tested for their value for protecting newly graded waterways from erosion.

Trash racks for drop inlets were studied on large test structures and on small models.

Special design studies conducted at the laboratory included the urban flood control channels at El Reno, Oklahoma, the noise and vibration of the drop inlet for Upper Clear Boggy Creek, Site 8, Oklahoma, and the Nichols Creek transition at Kenedy, Texas.

We have also done considerable research on developing flow measuring devices. The largest pre-calibrated flume was developed at the laboratory and installed in Walnut Gulch, Tombstone, Arizona. It has a flow capacity of 26,500 c.f.s.

The laboratory measured rainfall on and runoff from three grassland watersheds near stillwater, Oklahoma for 21 years. The study has been terminated, and a final report is being written.

What are we doing today? Presently Wendell Gwinn is testing trash racks for the low stage entrance of a two-staged drop inlet. I am testing a drop box inlet for a large chute spillway for Boomer Lake, Stillwater.

FORAGE GRASS SEED PRODUCTION RESEARCH
Stillwater, Oklahoma

Dr. R. M. Ahring is attempting to develop efficient cultural and management practices to provide maximum reproduction potential of introduced and improved native grasses. This is important supporting research in the general area of improved varieties. Unless seed can be made readily available, a new and improved variety is of no practical value.

During Fiscal Year 1974 investigations into the causes of winter-kill associated with establishment of two bermudagrass strains from seed were completed. The results showed: 1) Early spring emergence and stand vigor a year after establishment are major indicators of hardy materials; 2) Less hardy material, e.g., Common, are slow to recover because of reduced numbers of viable crown-buds per unit area, thus, spring tiller emergence is reduced and growth or cover slowed. Crown and rhizome buds of A-9945 were far superior to that of Common. Survival in Common was dependent almost entirely on crown-bud hardiness. Populations of parasitic nematodes infesting grasses (roots) grown for seed in pure stands were found to high (<5000/100 ml of soil). These were significantly high in areas sampled that exhibited depressed plant growth and lack of response to fertilization. Four one acre blocks were established to selected pairs of hardy cross compatible bermudagrass strains for seed production studies. A significant increase of seed produced by Caucasian bluestem was accomplished by nitrogen fertilization (100.8 kg N/ka). No beneficial effect on a brewer clay loam soil to phosphorus fertilization has been detected either alone or in combination with nitrogen. Summer cropping practices for fall weeping lovegrass seed production did not affect spring recovery and growth. Seed yield and seed stalks/ha were significant for nitrogen levels. It appears that seed-set and fill (seed-weight per head) are reasonably constant and are not increased or decreased by nitrogen fertilization; and the level of seed yield attained is dependent on numbers of seed stalks produced as a result of fertilization.

In Fiscal Year 1975, Dr. Ahring plans to:

a. Dormant rhizomes (sprigs) of several improved bermudagrass strains will be collected, washed free of soil, sized for length, and bud distribution. Selected volumes of rhizomes of each strain will be treated in a replicated study with several anti-transpirants and growth inhibiting chemicals, and stored under room, moist humid, and cool dry conditions. Cloth, plastic, and laminated paper bags will be evaluated as containers. Rhizome viability will be checked prior to treatment and at regular intervals throughout. Prior to storage a preliminary study will be conducted on 1) the amounts of growth-inhibitor (ppm) needed to inhibit or induce deep bud dormancy, and 2) methods of promoting bud germination of treated sprigs. Most of the growth inhibiting chemicals are considered anti-gibberellins. Therefore

varying the ppm or concentration of gibberellic acid in substrate moisture will be used in trial attempts to promote bud germination.

b. Although some insects are not seed feeders in the strict sense, their habits and other circumstances may combine at times to permit them to seriously affect seed production of grasses grown in pure stands. Insect larvae that live in the upper layer of the soil feeding on roots of the area as well as parasitic nematodes populations that increase through host preference will be studied.

Cooperative research has been initiated on this problem with the Department of Botany and Plant Pathology, in addition to the Entomology Department, Oklahoma State University.

c. The major variables subject to investigation are: nitrogen and phosphorus requirements including time and rates; alteration of growth stages and time of flowering by clipping, root pruning, burning, and other renovation practices; moisture requirements with respect to different stages of growth, and weed, disease, and insect control. It is impossible to apply all combinations of these variables in one study on a single species. Fertility and water requirements will be continued with special emphasis on new species (Asiatic bluestems) not previously investigated. Nitrogen requirements, alteration of growth and time of flowering by clipping will be studied on bermudagrass and on the fall seed crop of weeping lovegrass. Data in addition to seed yield will be collected on two major components of high seed yield, a) number of seed stalks (inflorescence) and florets per inflorescence and b) number of florets to set seed.

d. Concentrated seed extract preparations of *P. anceps* will be used to determine the germination inhibiting or promoting properties on other non-dormant seeds. Isolation of inhibitors will be accomplished by paper chromatography. The chemical nature of the inhibitor will be determined using known substances and employing the visualization reagents, thin layer chromatography and gas liquid chromatography.

e. A thermogradient plate has been constructed for use as a tool to locate temperature ranges favorable for the germination of different grass seeds. Factors to be studied include light (photoperiod), temperature and temperature regimes, various inorganic salts, and substrates as they effect germination and seedling growth.

SUMMARY OF RANGE AND PASTURE MANAGEMENT RESEARCH
U. S. Southern Great Plains Field Station
Woodward, Oklahoma[1/]

Program Mission: Agricultural Production and Marketing Efficiency.

Research Activity: Improved Range Management Systems.

General Objectives: Develop (1) range improvement tools, (2) annual and perennial tame pastures, and (3) ranching practices (including management systems) that will increase quantity and quality of range and pasture forages in the Southern Plains, and will convert the forages to beef with the most biological and economical efficiency--with high regard for soil and energy conservation, wildlife, water production, recreation and aesthetics.

Climate and Soils: Precipitation averages 16" in summer, 6" in winter, and 22" annually, with a range of 10" to 41". Evaporation averages 95" annually. Temperature extremes are -27° to 114°. Winds are high. Elevation is 2000' above sea level. The three major soils are sandyland (Pratt, Tivoli, Brownfield, Nobscot), redlands (Quinlan, Woodward, Vernon), and gray soils of the Caprock Breaks (Potter, Mansker).

Research Facilities: Over 4,700 acres of sandsage rangeland (Pratt-Tivoli soils) divided into 90 pastures; 500 acres of cultivated land (Woodward and Carey soils); greenhouse; root chamber; offices; labs; barns; etc.

Research Measurements: Grazing results are obtained with 600 stocker steers, 50 cow-calf pairs and precise measurements of forage production and species composition. Most studies are complete systems (or small ranches) with complete economic records. Our harvest product is not bushels/acre, but beef/acre (produced by high and profitable gains/animal).

Research Results:

1. Generalized forage yields are:

	Lbs/acre
Native rangeland	1,000 ± 500
Wheat and/or rye for graze-out	3,000 ± 1,000
Tame pasture	5,000 ± 2,000
Sudan and forage sorghums	6,000 ± 2,000

2. Compared with native range alone, a complementary pasture system of 90% rangeland-10% weeping lovegrass increased beef and profits 50% (3 yr).

1/ Prepared by E. H. McIlvain, research agronomist, U. S. Department of Agriculture, Agricultural Research Service, Southern Region, for the Joint SCS-ARS Workshop, Fort Worth, Texas, April 16-18, 1974.

3. Compared with native range alone, a complementary pasture system of 75% rangeland-25% double cropped wheat-sudan for graze-out doubled beef and profits (7 yr).

4. Compared with native grass alone, a complementary pasture system of 50% lovegrass-50% wheat-sudan, quadrupled beef and profits (6 yr).

5. Stocking rate is based on harvestable forage and not on forage production. For instance:

<u>Apparent increase:</u>	<u>Range</u>	<u>Lovegrass</u>
Forage yield, lbs/acre	1,000	5,000
Increase over range, times		5
<u>Real increase:</u>		
Loss to trampling, insects, rodents, weathering, disease, etc., lbs/acre	-300	-500
Ungrazed residuum, lbs/acre	-300	-500
Grazeable forage, lbs/acre	400	4,000
Increase over range, times		10

6. Forage production of weeping lovegrass doubles each 10 days, but after 40-45 days, quality nosedives.

7. Moderate use of rangeland (not over 40% use by frost) was much more profitable on a sustained basis than was either heavy or light use (20 yr).

8. Rotation systems on our semiarid sandsage rangelands did not increase forage, beef, or profits. Significant growth opportunities are infrequent and of short duration. Some years we have none. All aspects of range management must be directed toward taking full advantage of each growth opportunity.

9. Uniform distribution of livestock grazing pressure on each square yards and on each acre was all-important.

10. A single clean-up <u>mowing</u> of old grass growth on sandy native range increased summerlong gain of steers an average of 30 lbs/hd for 3 years.

11. A single clean-up <u>grazing</u> of old grass growth increased steer gains 10 lbs/hd.

12. On rangeland, 1 blade of grass out of 3 disappears.

13. All of our long-lived perennial grasses suffer a horrendous sodbound syndrome.

14. September and October grazing is more detrimental than grazing at any other season.

15. Cutting weeping lovegrass at a 4-inch stubble height yielded $4.00 more net hay per acre than cutting at 2 inches (4 yr).

16. Cutting weeping lovegrass at 45-day intervals, rather than at 30 days, yielded an additional $4.00 more hay per acre (4 yr).

17. Stand thinning of weeping lovegrass by a single tillage treatment in 1971 increased hay production 7, 25, and 12% for 3 years, respectively. The single tillage cost $2.50/acre, and it netted $15.35/acre more hay as a 3-year total.

18. A ground cover of litter (1/2" deep) between lovegrass plants increased 1973 forage yield 26% and produced $7.00 net more hay/acre than on plots where litter had been removed.

19. Applying 5-10-0 in the downspout with nearly all species of grass seed increased establishment vigor about 25% on our average low-fertility soils.

20. Treating grass seeds with copper carbonate also increased establishment and vigor 10-25%.

21. Warm-season range grasses should be planted about 1/2" deep in early spring (usually March) into a very firm, stubble-protected seedbed prepared the previous year.

22. Low cut and thin stubble on the seedbed is preferable to uncut or thick stubble.

23. Weeds and sometimes insects must be controlled the first summer following seeding of range grasses, and mowing for weed control is preferable to using 2,4-D if grassy weeds are abundant.

24. Applying 30 lbs N/acre on Caucasian bluestem increased carrying capacity 24%, yearlong gain per steer 60 lbs or 18%, gain per acre 48%, and net profit 72% (4 yr).

25. Two 30 lb N/acre applications per summer on weeping lovegrass increased forage and beef production 3-fold—and was usually more efficient than either 1 or 3.

26. Applying 30 lbs N/acre annually for 6 years on sandy native range did not significantly alter species composition, forage production, or beef gains per steer or per acre. It was not a profitable practice.

27. The most economical method of controlling shinnery oak by airplane is to spray in early May with 1/4 lb 2,4,5-T ester in 1 gal carrier/acre—on an as-needed basis which is about once each 5 years.

28. The most economical method of controlling sand sagebrush by airplane is to spray in early May with 1/2 lb 2,4-D ester in 1 gal carrier/acre; on an as-needed basis which is about once each 10 years.

29. However, we have developed a pickup or tractor technique for suppressing brush and weeds that costs only one-tenth as much as airplane control. Forage production is increased 50-300%. The method involves sprayer trails—pickup-mounted mistblowers (or boom sprayers)—and defoliation doses of herbicides. Each tree and each clump of brush or weeds is treated on an eye-to-eye basis. Effective rates of herbicide are 1/8 and 1/16 lb in 1 gal water/acre. The control principle is to exhaust root reserves. Successive sprayings are synergistic, and drouth is an asset.

30. Burning shinnery oak rangeland in April to remove shinnery top growth and excessive old growth of range grasses increased forage yield 21% as a 10-year average.

31. Burning old growth of weeping lovegrass in April increased steer gains 40 pounds per head and natural seedling establishment more than 10-fold.

32. A daily ration of 1.5 lb of 41% protein supplement was optimum in winter for both weaned stockers and spring-calving cows on sandsage rangelands.

33. Feeding 1 lb of 41% cake on brown grass in late summer is profitable.

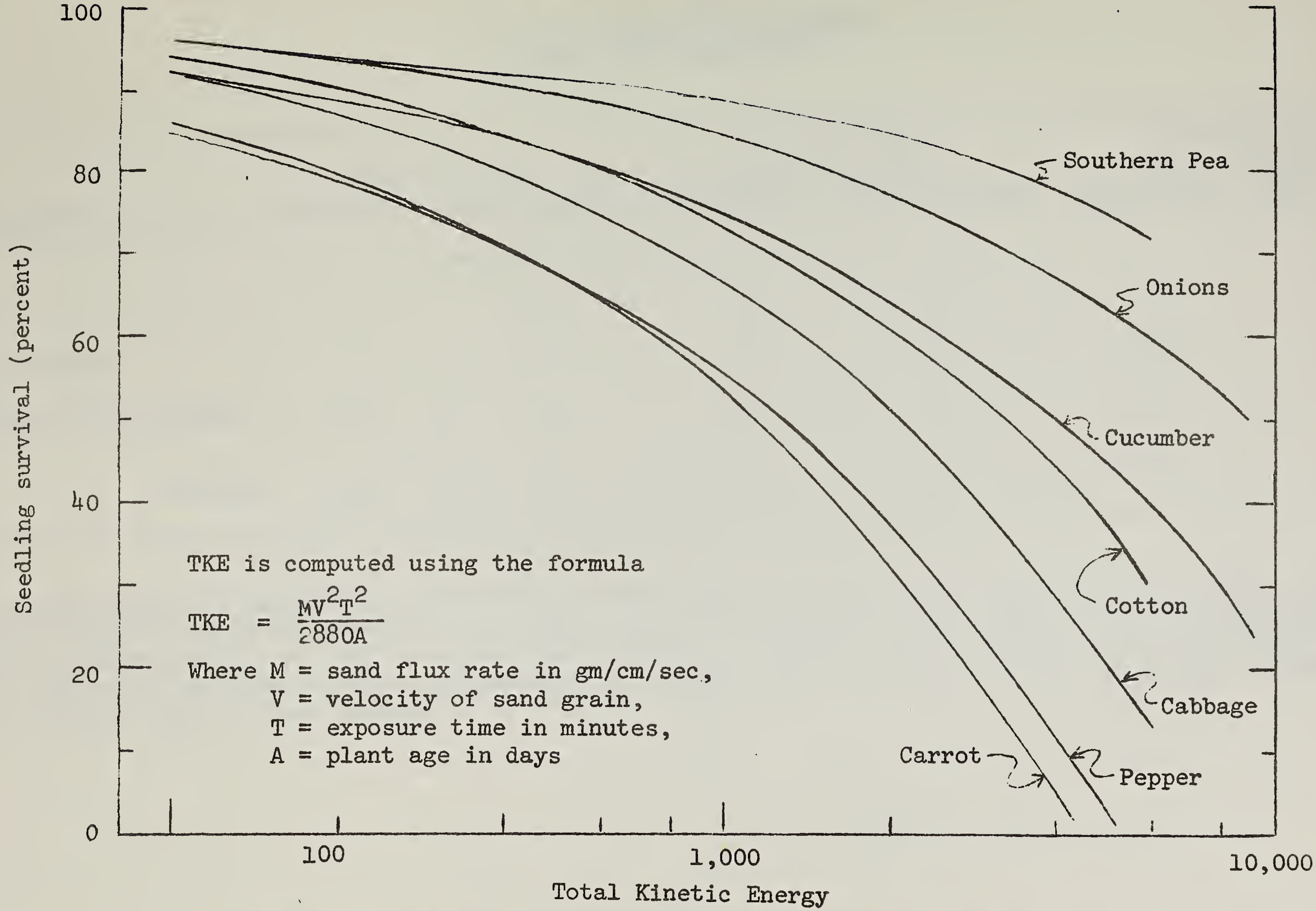
34. Twice-a-week caking was as effective as daily caking.

35. Implanting only 12 mg stilbestrol in stocker steers on Nov 1 and again May 1 increased yearlong gain 45 lbs. Ralgro also increased gains 45 lbs.

36. Steer-gain and economic responses to feeding low levels of supplemental energy (1 to 4 lbs. of cracked grain sorghum daily) are highly erratic from year to year.

37. Shade increased steer gains 20 lbs per head during a 4-year study. Humidity is the culprit. Each hot, muggy day reduced summerlong steer gains by 1 pound.

U. S. BIG SPRING FIELD STATION
WIND PLANT INJURY STUDY

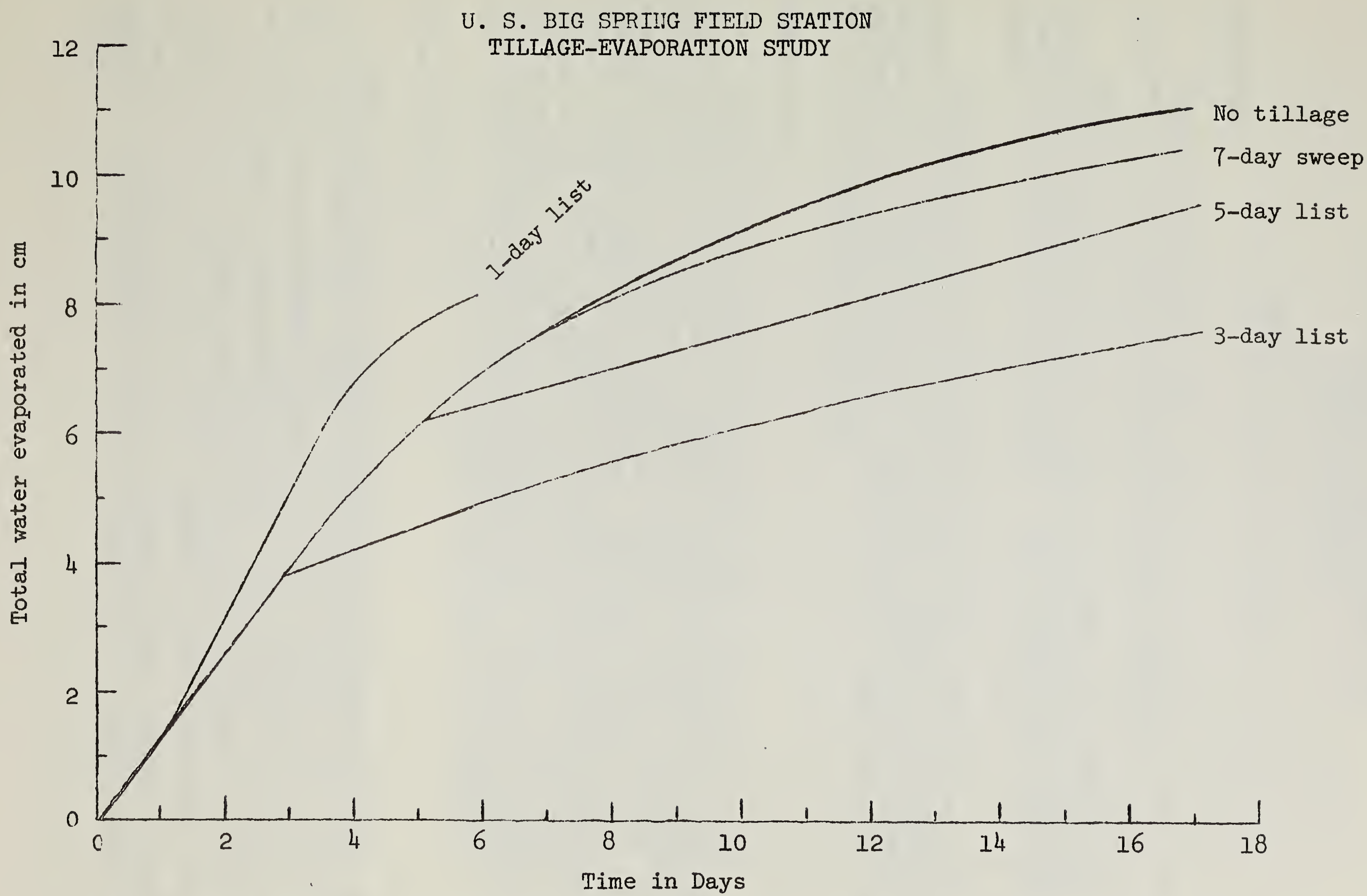


Relation between total kinetic energy (TKE) of a sand storm and plant survival. These relations are useful in comparing plant tolerance to wind damage, in deciding if a damaged crop should be replanted, and are essential in designing erosion control systems. Exposure of 6-day-old seedlings to a 1,500 cm/sec wind, 0.5 gm/cm/sec sand flux for 7 minutes will have a TKE value of 1,000. Relationships between TKE and crop yield are being developed.

U. S. BIG SPRING FIELD STATION
GRASS PRODUCTION STUDY

Month Harvested	Rainfall only		Rainfall plus limited irrigation		Rainfall plus heavy irrigation	
	Switchgrass	Cane bluestem	Switchgrass	Cane bluestem	Switchgrass	Cane bluestem
	t/ha					
October	2.1	4.5	6.2	10.8	7.4	11.2
July and October	2.0	5.3	5.7	10.0	6.3	9.0
June, August, and October	1.8	4.6	5.6	8.0	6.5	8.0
Average	1.9	4.8	5.9	9.6	6.7	9.4

Total forage yield of two grasses as influenced by frequency of harvest and availability of water. Yield values are the average of 3 years and 3 ecotypes. The cane bluestem ecotype G-866 outyielded G-820 and PMT-333 on rainfall only, but G-820 produced more forage on rainfall plus irrigation. The switchgrass ecotype G-300 produced more forage than blackwell or HV-341 under all soil moisture conditions. Forage quality was best for the dual clipping.



Accumulated evaporation from a sandy soil after the soil has been saturated and then tilled. Soil was subjected to a heat load of 0.5 langley/minute for 12 hours each day. Wind load was constant at 10 mph. Tillage was 2 inches deep with a model lister or a 3-inch wide sweep. Total evaporation was higher with wind load only because first stage drying extended into the eighth day.

Information From
U. S. Big Spring Field Station for
SCS-ARS Workshop
April 16-18, 1974

Presented by Bill Fryrear

Mulching:

Surface mulching has been evaluated as a method of controlling wind erosion and improving soil-plant-water relations.

Mulching with 5 T/acre of cotton gin trash will control wind erosion on a loamy fine sand. This is the minimum mulch rate that completely covered the soil surface. The 5 T/acre mulch rate was nearly as effective in improving soil water relations as the 10 T/acre.

Mulching will also increase soil aggregate stability and will reduce wind erodibility even when the soil surface is not physically protected by the surface mulch. Mulching does increase the weed problem, and we have had more problems with cut worms where 10 T/acre of mulch was applied to the soil.

Plant Injury:

If sandy soils cannot be protected from wind erosion, crop establishment is a problem. Research has been conducted to determine how much injury a crop can withstand and still recover and produce an acceptable crop. We have developed a method of determining the total kinetic energy (TKE) in a wind storm. The TKE in Figure 1 may not be useful to the farmer to estimate survival so the relation between a visual rating of crop injury and crop survival will be developed. An SCS technician or a farmer can rate the crop injury and determine survival and production from the damaged crop. This will provide a sound basis to determine if a damaged crop should be replanted.

Grass Production:

Three switchgrass ecotypes and three cane bluestem ecotypes were grown under three water regimes: W_3 (20 cm irrigation when the upper 180 cm of soil is depleted 20 cm); W_2 (10 cm irrigation when W_3 is irrigated); and W_1 (precipitation only). All ecotypes were subjected to three harvest regimes removing one-half of the growth: H_1 (one clipping at the end of the growing season); H_2 (two clippings, mid- and end-of-growing season); and H_3 (frequent evenly spaced clippings beginning when one-half of forage is removed with a stubble height of 30 cm).

Precipitation for November through March of 1970 and 1973 was 16.7 and 14.1 cm, respectively, resulting in good soil water supply at the beginning of the growing season. The preseason precipitation for the 1971 and 1972 growing seasons was 2.2 cm or less, but above normal precipitation was received during the growing season.

The switchgrasses gave the highest yield in 1971 and 1972 indicating that abundant precipitation during the growing season is most beneficial (Table 1). Yields were increased by additional water even in wet years. The G-300, a southernmost ecotype, out produced the Blackwell and HV-341. Evidently harvesting frequency has little effect on switchgrass yields.

Because of establishment difficulty, only 3 years of data were collected on the cane bluestems. Cane bluestems produce similar yields with full and limited irrigations and more than with precipitation only (Table 2). They respond to additional water and to optimum soil-water level. The G-820 ecotype from a more mesic site of Mexico outyielded the G-866 from a more droughty situation also from Mexico. The G-866, however, tended to outyield the G-820 with precipitation only. Also yields were lowered when clipped more than twice during the growing season. The cane bluestems outyielded the switchgrasses under the conditions of this study.

Crop Management:

How can the blank rows in a skip row cotton production system be managed to reduce wind erosion hazards and maintain cotton production? Two years of results show that pearl millet planted in August will not reduce cotton production and will provide enough cover to protect sandy soils from wind erosion. The 1973 crop was hailed on September 4 so cotton yields were reduced (Table 3).

Tillage:

Every farmer tills the soil. The type and number of operations will depend on the soil type, crop grown, and the region of the county. Tillage research does provide an opportunity to reduce production expenses, control erosion, and conserve soil water. The interactions of soil, tillage, and crop are very complex. The main objective of our tillage research is to maintain crop production while reducing the number or type of tillage operations required to produce a crop. Research conducted by Dr. G. H. Moore shows that appreciable quantities of water can be saved by tilling at the proper time following a rain (Figure 2). We have a study underway to determine the fuel, labor, wind erodibility, and cotton production from various confined traffic and limited tillage systems.

Table 1. Forage yields of three switchgrass ecotypes in t/ha under three water and harvest regimes for 1970, 1971, 1972, and 1973.

Ecotypes	Water regime W_1	W_2	W_3	Harvest regime H_1	H_2	H_3	Average
				1970			
Blackwell	1.716	4.423	5.347	3.198	3.331	4.957	3.829c*
G-300	1.838	4.715	6.077	4.194	4.806	3.630	4.210c
HV-341	1.386	4.290	5.810	3.551	3.322	4.613	3.829c
Average	1.647e	4.476cd	5.744bc	3.648	3.820	4.400	3.956B**
				1971			
Blackwell	3.308	5.682	5.868	4.752	5.043	5.062	4.952bc
G-300	3.971	6.860	7.913	7.871	6.082	4.791	6.248ab
HV-341	3.014	6.862	7.895	6.603	6.074	5.094	5.924b
Average	3.431d	6.468ab	7.226ab	6.409	5.733	4.982	5.708A
				1972			
Blackwell	0.670	5.112	5.811	3.823	3.952	3.818	3.864c
G-300	2.467	9.315	10.346	10.121	6.354	5.653	7.376a
HV-341	0.792	6.307	6.995	4.437	4.736	4.922	4.698bc
Average	1.310e	6.911ab	7.718a	6.127	5.014	4.798	5.313A
				1973			
Blackwell	0.885	4.933	4.784	3.383	3.537	3.683	3.534c
G-300	2.398	6.573	8.222	7.306	4.845	5.042	5.731b
HV-341	0.882	5.149	5.465	3.527	4.003	3.965	3.832c
Average	1.388c	5.552bc	6.157ab	4.739	4.128	4.230	4.366B
				4-year averages			
Blackwell	1.645	5.038	5.453	3.789c	3.966c	4.380c	4.045B
G-300	2.669	6.866	8.140	7.373a	5.522ab	4.779bc	5.891A
HV-341	1.519	5.652	6.541	4.530bc	4.534bc	4.649bc	4.571B
Means	1.944C	5.852B	6.711A	5.231A	4.674A	4.603A	4.836

*Interaction averages with different lower case letters are significantly different at the 5 percent level of probability.

**Main treatment means with different upper case letters are significantly different at the 5 percent level of probability.

Table 2. Forage yields of three cane bluestem ecotypes in t/ha under three water and harvest regimes for 1971, 1972, and 1973.

Ecotypes	Water regime			Harvest regime			Average
	W_1	W_2	W_3	H_1	H_2	H_3	
				1971			
G-866	6.825	8.167	8.298	7.991	8.261	7.039	7.764
G-820	6.175	11.445	11.602	11.457	10.523	7.241	9.740
PMT-333	4.318	6.705	6.996	6.429	6.857	4.732	6.006
Average	5.773	8.772	8.965	8.626	8.547	6.337	7.837B*
				1972			
G-866	5.355	11.695	9.928	9.775	8.957	8.246	8.993
G-820	4.613	14.841	13.522	13.746	10.419	8.811	10.992
PMT-333	3.315	10.680	9.913	9.328	7.892	6.688	7.969
Average	4.428	12.405	11.121	10.950	9.089	7.915	9.318A
				1973			
G-866	4.802	7.174	6.612	6.152	6.329	6.107	6.196
G-820	4.089	8.721	9.272	8.417	7.059	6.605	7.360
PMT-333	3.402	6.498	8.134	6.073	6.435	5.526	6.011
Average	4.097	7.464	8.006	6.881	6.607	6.080	6.522C
				3-year averages			
G-866	5.661c**	9.012b	8.279b	7.973bc	7.849bc	7.131cd	7.651B
G-820	4.959cd	11.669a	11.465a	11.207a	9.334b	7.552c	9.364A
PMT-333	3.678d	7.961b	8.348b	7.277cd	7.061cd	5.649d	6.662C
Means	4.766B	9.547A	9.364A	8.819A	8.081A	6.777B	7.892

*Main treatment means with different upper case letters are significantly different at the 5 percent level of probability.

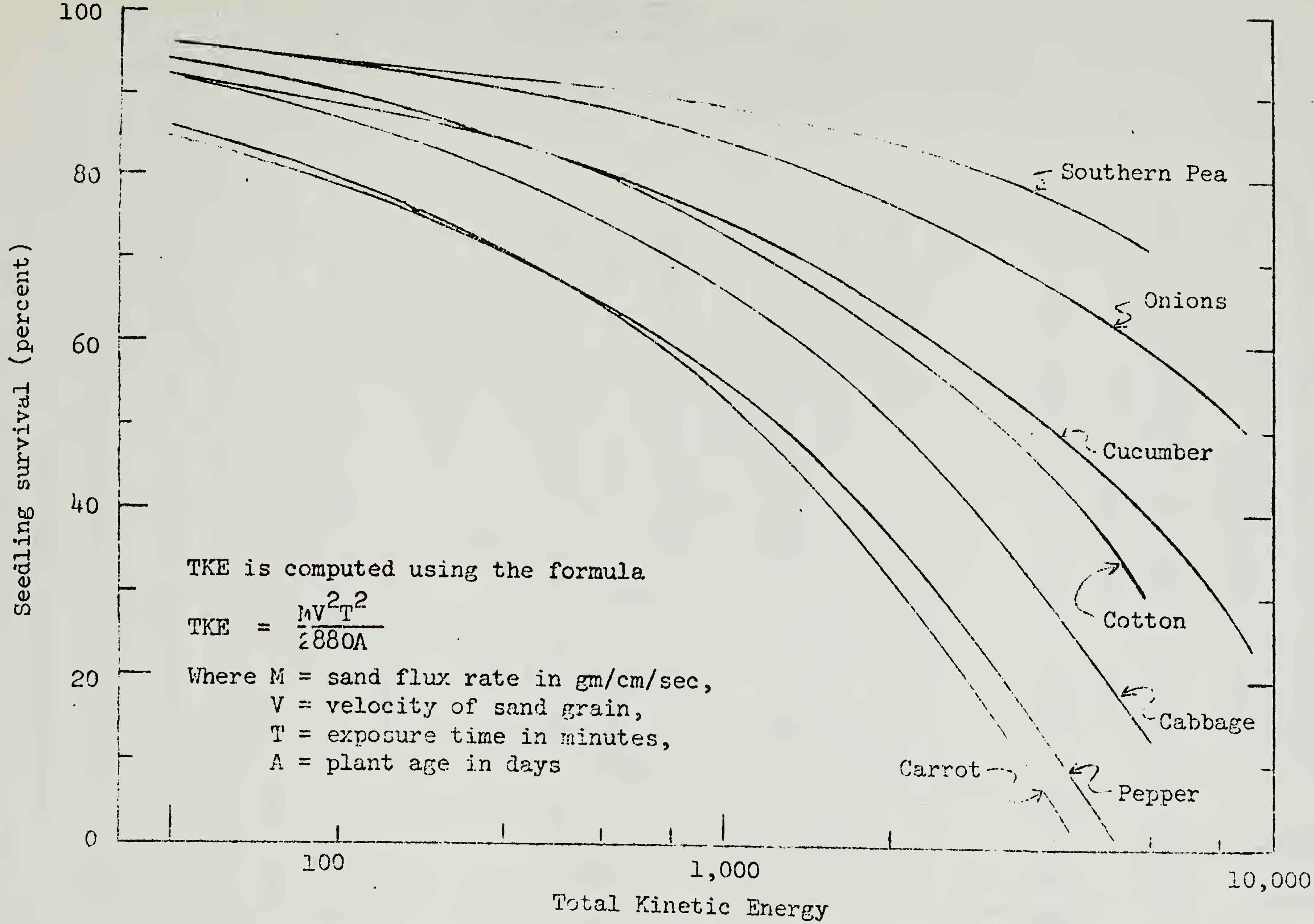
**Interaction averages with different lower case letters are significantly different at the 5 percent level of probability.

Table 3. Crop yields from 2 X 2 dryland cotton.

Blanks	Planting date*	Blank row crop yield	Continuous cotton	Alternate cotton
		pounds/acre		
Clean	-	-	230	210
Border dike	-	-	175	214
Grain sorghum	June 5, 1973	625	112	110
Grain sorghum	July 9, 1973	87	172	215
Pearl millet	August 16, 1973	3	210	262
Pearl millet	August 3, 1973	11	254	258
Proso millet	August 3, 1973	0	280	295
Proso millet	August 16, 1973	0	249	248
Wheat	September 13, 1972	0	270	212
Wheat	October 6, 1972	0	212	215
Gin trash	February 5, 1973	0	237	239
Guar	July 9, 1973	0	232	215
Average			219	224

*Date blanks were planted. Cotton was replanted on June 17, 1973.

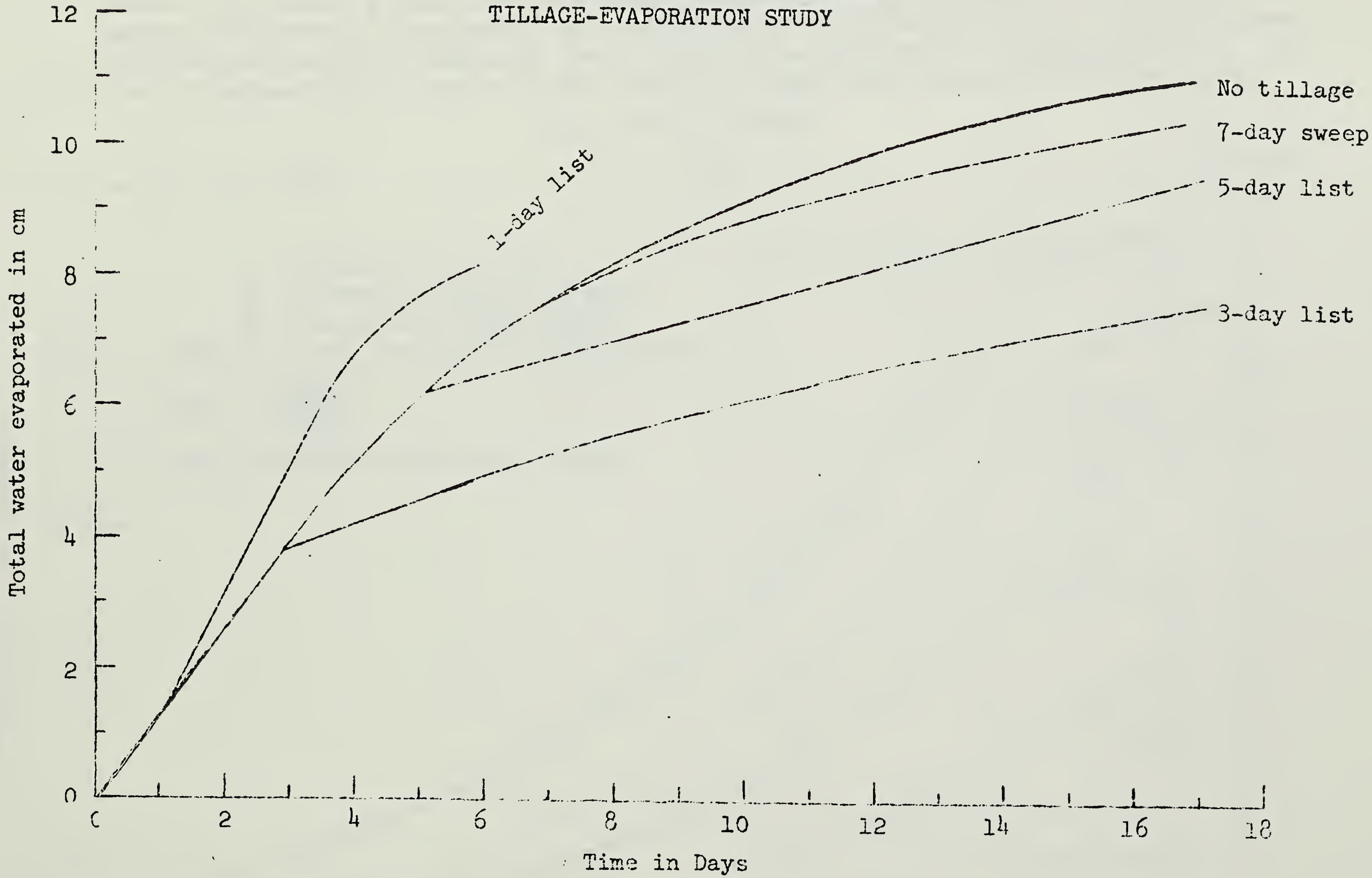
U. S. BIG SPRING FIELD STATION
WIND PLANT INJURY STUDY



Relation between total kinetic energy (TKE) of a sand storm and plant survival. These relations are useful in comparing plant tolerance to wind damage, in deciding if a damaged crop should be replanted, and are essential in designing erosion control systems. Exposure of 6-day-old seedlings to a 1,500 cm/sec wind, 0.5 gm/cm/sec sand flux for 7 minutes will have a TKE value of 1,000. Relationships between TKE and crop yield are being developed.

FIGURE 1

U. S. BIG SPRING FIELD STATION
TILLAGE-EVAPORATION STUDY



Accumulated evaporation from a sandy soil after the soil has been saturated and then tilled. Soil was subjected to a heat load of 0.5 langley/minute for 12 hours each day. Wind load was constant at 10 mph. Tillage was 2 inches deep with a model lister or a 3-inch wide sweep. Total evaporation was higher with wind load only because first stage drying extended into the eighth day.

FIGURE 2

RESEARCH PROGRAM AT THE USDA SOUTHWESTERN GREAT PLAINS RESEARCH CENTER, BUSHLAND, TEXAS

B. A. Stewart, Research Leader

The Center is located at Bushland, 10 miles west of Amarillo. The elevation is 3800 feet and the average rainfall is 18.5 inches. It serves the large and productive agricultural area of the Southern High Plains.

The research centers around five topics as follows:

1. Recharging ground water for agricultural and urban uses
2. Efficient irrigation and agricultural water use
3. Efficient water use on nonirrigated land
4. Maintenance of soil fertility
5. Management of animal wastes

A brief discussion of each activity is presented. However, a list of all published reports is available from the Center if detailed information about a particular area of research is desired.

1. Recharging Ground Water

The water table in much of the irrigated area of the Southern High Plains is dropping at the rate of about 2 feet per year. A substantial amount of runoff water is impounded in the playa lakes that dot the landscape. Successful methods for recharging the ground water aquifer with this runoff would slow the decline rate of the water table. Perhaps as much as 15 percent of the water being pumped from the aquifer could be replenished.

The most promising approach for a practical recharge system appears to be the use of recharge basins. Data obtained during the past

5 years have shown that basins developed by removing the top 3 to 4 feet of the soil profile are effective as recharge basins. The runoff water impounded in the playa is pumped to the basin and allowed to infiltrate. As the surface of the basin becomes plugged with sediment, pumping is stopped and the basin allowed to dry. The dried sediment is then removed from the basin and another recharge cycle is begun. Over a 5-year interval, 432 feet of turbid water has been recharged during 11 flooding cycles that totaled 304 days.

2. Efficient Irrigation and Agricultural Water Use

The Southern High Plains has approximately 7 million acres of land under irrigation. This project is directed toward management and efficient use of limited irrigation with emphasis on developing irrigated farming systems that will better utilize the rainfall along with the irrigation water. The use of alternating drill width strips of wheat and sorghum have proved successful by (a) limiting the number of seasonal applications, and (b) limiting the number of irrigated furrows per drill strip. The outside rows of the growing crop can obtain some water from the adjacent strip since the two crops do not grow during the same season. Double cropping has also showed promise of utilizing a higher percentage of the rainfall. The use of chemical fallow after wheat and surface residue management after sorghum shows real promise in conserving water from precipitation. The use of limited till systems appears to offer the potential of cutting irrigation water demands by 25 percent.

3. Efficient Water Use on Nonirrigated Land

The overall objective is to utilize water more efficiently through increased infiltration, storage, and reduced evaporation. Leaving

residues on the surface has a pronounced effect on increasing soil water storage providing there is sufficient residue. Under dryland conditions, sufficient residues are often not available. Consequently, alternating dryland and irrigated crops appears promising as a means of making more efficient use of precipitation. Utilizing the residues of an irrigated crop to conserve precipitation for the production of a dryland crop the following year has proved successful.

The use of water harvesting systems also has application to the area. Fourteen years of data have been collected on a conservation bench terrace system.

4. Maintenance of Soil Fertility

The primary objective is to maintain a maximum efficiency of water use in crop production through the maintenance of optimum plant nutrient levels. Major emphasis has been on nitrogen, since this is the first limiting nutrient for most crop production systems in the area. Substantial data has also been obtained on the fertilizer practices necessary to restore productivity to lands that have had varying amounts of soil removed during land leveling.

5. Animal Waste Management

The emphasis is to develop agricultural practices that will control and utilize animal wastes without environmental pollution. Results from 5 years of field study show that yearly rates of manure up to 60 tons per acre can be applied without reducing sorghum yields. However, proper water management is required to minimize salinity hazards. Also, nitrate accumulations are significant when excessive amounts of

manure are added. Consequently, the practice of applying large amounts of manure to cropland should be avoided and emphasis placed on applying the rates necessary to provide optimum nitrogen levels for plant growth. Under most conditions of the Southern High Plains, those rates would be from 10 to 15 tons per acre yearly. Waterintake water rates were increased on plots receiving manure.

Data have been obtained on the amount and characteristics of runoff from feedlots. There is generally no runoff from a feedlot from rainfall of a half inch or less. About one-third of the precipitation from storms greater than one-half inch runs off the feedlot. This is less runoff than has been measured in more humid feeding areas.

Thursday, April 18, 1974 Summary Notes - Frank Erichsen, Recorder

1. E. C. Bashaw, College Station, Texas discussed the results of grass breeding research at the ARS Station at Texas A&M University. He listed the objectives of his studies, and showed slides to summarize his work on:

   A. Kleingrass - breeding program

   B. Bermudagrass developments

   C. Weeping lovegrass

   D. Buffelgrass - Improved strains and new matings achieved; objective is also to make new strains adaptable for wider use in Central Texas.

   He pointed out that the recent developments in buffelgrass show great promise and that ARS needs help from SCS to "sell" the new products to ranchers and others. An excellent presentation.

   During the question and answer period, the question of burning was discussed, and it was pointed out that EPA controls are considered a restraint by some people.

   The complete paper, "New Developments in Grass Breeding in the Oklahoma-Texas Area", presented by Mr. Bashaw is included for further review.

2. R. W. Bovey, College Station, Texas discussed brush control research results and methods tested for prevention of pesticide drift from one area into an adjacent area. It was pointed out that 55 million acres in Texas are mesquite covered. Slides were shown to illustrate possible treatment of mesquite by sprays, but that mesquite leaves are susceptible to herbicides only a short period of time and build up a waxy resistance on the leaf, making spray ineffective. Illustrations were presented of greenhouse studies of herbicide applications to plants. Slides showed aerial spray equipment and the detrimental effects of drift, but pointed out EPA constraints on aerial spraying. New types of jet spray applicators have been developed for field testing to prevent spray drift. Foam sprays apparently are not too successful. Attempts are being made to inject spray material directly into the soil itself. The question raised about treating running mesquite in West Texas indicates that studies on its control are being handled by Texas A&M.

   The complete paper presented by Mr. Bovey is included for further review.

3. Earl Burnett, Temple, Texas reviewed the six major areas of research at that ARS station, the Blackland Conservation Research Center. This is an older station with research plots and watershed studies since 1936 at Riesel and Temple, Texas. Discussion centered around grassland research on the Houston Black clay soil in the Texas Blackland Prairie area, with its shrink and swell characteristics, and the extremely low permeability of .005 inch per hour. Erosion control work with specially constructed deep furrows was discussed as a means to eliminate building terraces. Effects of fertilizer application rate and row spacing on sorghum yield were summarized. The large reductions in hydrograph runoff volume and soil loss from cropland with this new deep furrow were strikingly portrayed. It is anticipated that this new procedure will probably replace terraces as a soil and water conservation practice in the future.

   The paper, "Research Relating to SCS Needs", presented by Mr. Burnett is included for further review.

4. C. L. Wiegand, Weslaco, Texas reported on experiments being conducted in soil and water research in South Texas in the Rio Grande Valley area. Slides were shown to illustrate the studies on the tight Harlingen clay soil. Reported were studies on cotton yield. Solid waste disposal procedures are being studied. It was pointed out that over 400,000 acres of land in South Texas have been mechanically leveled to zero-percent grade. Methods are being tested to save irrigation water. Sprinkler irrigation is being used to establish vegetable plants to be followed by furrow irrigation at quite a saving in water use. Irrigation results in citrus grapefruit orchards were reported on. Studies of ground water level as affecting yield of grasses were summarized. The salinity problem in some areas where drainage is used was pointed out. Studies are underway to improve designs of drainage systems. Plant management work was reported on. Cooperation with similar research being conducted in Mexico and interchange of research results are being carried out.

   The handout distributed by Mr. Wiegand is included for further review.

5. General Discussion and Summary Statements

   A. Rex Johnston expressed his appreciation to the nine ARS area office personnel who prepared and presented papers and discussions at this highly successful joint meeting of ARS and SCS. One of the major objectives was to build upon and strengthen the good working relationship between the two agencies, ARS and SCS. This was certainly accomplished at this meeting. Benefits to both agencies will continue to surface in the future. Personal contacts will be the real payoff and should be followed up. ARS has a fund of information which will be helpful to SCS in developing environmental impact statements, and it is available upon request and contact with ARS personnel.

B. Jack Adair pointed out that Engineering Memo-72 sets up SCS criteria for channel design. Had these criteria been available and followed in some of the early channel design jobs, there would have been fewer problems like the bank erosion which has occurred in a few SCS completed channels. We now use criteria including considerations of allowable velocity in TR-25, tractive force analysis, bedload studies, more vegetative protection of channel banks and berms, etc.

C. Richard Wenberg discussed channel design criteria, and pointed out the significance of the tractive force analysis in certain situations. He mentioned the contacts with Dr. Little at the Oxford, Mississippi Research Station to obtain information on past research on channel design, and the need for answers to designs in nonplastic soils. SCS will make a special request to ARS at Oxford on tractive force data. Wenberg and Dr. Little will plan a meeting to discuss this special problem.

D. T. V. Jamieson discussed waste management and disposal problems and solutions in Florida. He showed slides on wave action protection by vegetation on floodwater retarding dams as a far cheaper way to control erosion than use of riprap. A slide showed the latest thinking on channel protection by planting trees at the bottom of newly constructed side slopes coupled with vegetation on the side slopes and berms. He pointed out the need for channel maintenance, the use of water control structures, and vegetation of channel banks. SCS still needs assistance on stabilizing channel banks by vegetative measures.

E. Crawford Young discussed the needs for plants in the SCS programs and that the scope of SCS vegetative work has expanded into landfill disposal vegetation, wave action control, etc. He suggested a model study on wave action vegetation as a much cheaper control measure than rock riprap. The use of maidencane, a native vegetative material, at the base of channel side slopes was discussed and excellent results reported. Other types of streambank stabilization vegetative plants were shown by slides. The need for forage grasses that are perennial and will grow in the Southern Coastal Plains area was reported on.

F. Arnold Snowden indicated the SCS's need for factual data from ARS research reports for use as reference material in handling environmental impact statement development.

G. Dr. Cooper, ARS, responded to various SCS needs and indicated he would provide as much assistance as possible. He pointed out the desirability of person-to-person contacts to have ARS personnel get a better understanding of SCS needs. ARS has a national group of editors who could provide SCS with copies of available papers

and papers being prepared for publication.

H. Jack Adair expressed appreciation for ARS efforts in preparation and presentation resulting in an excellent workshop which was mutually beneficial to both agencies.

I. Dr. Cooper concluded the workshop by expressing his appreciation for the excellent arrangements by SCS and thanked the ARS participants for excellent presentations. He stated that this was a most productive session which had attained the three major objectives set up for the meeting.

New Developments in Grass Breeding in the Oklahoma-Texas Area

E. C. Bashaw, ARS Geneticist
College Station, Texas

Plant breeders and plant materials specialists are primarily concerned with discovery or development of new and improved forages for pasture production, revegetation, conservation of land and environment, and recreation. Best results are obtained when the efforts of these scientists are coordinated and directed toward our common goal. I am especially pleased to report that we have achieved a very productive grass development program in the Oklahoma-Texas Area that involves the cooperative efforts of ARS, SCS and the State Experiment Stations. A brief report of progress, new developments and future prospects follows.

We have long recognized that one of our greatest needs in the South is for highly productive and nutritious forages which can be established and managed effectively and economically in our livestock programs. The development of such forages is a slow and time-consuming process. It involves gradual modification of existing strains, or the discovery of new plants and recombination of good characteristics through hybridization. Unfortunately many of our most promising perennial grasses have peculiar reproductive problems which require considerable basic genetic research before successful breeding techniques can be developed. We have solved many of these problems during the past 20 years and have finally discovered ways to improve many of the grasses.

Buffelgrass

The story of our experiences with buffelgrass will illustrate a serious problem in the improvement of several of our most important Southern grasses, and also indicate exciting new prospects for breeding these species. Buffelgrass has a strange method of reproduction called apomixis; a way of producing seed without the usual fertilization process. Apomixis prevents hybridization and development of new strains. It is present in many of our grasses including lovegrass, side oats, bluestems, guineagrass, dallisgrass and bahiagrass, and accounts for the lack of progress in the improvement of these species. After many years of basic research we unravelled the mysteries of apomixis and discovered that a few normal sexual plants are usually available if you can identify them. Such was the case with buffelgrass, and we finally obtained a sexual plant which could be pollinated with the apomictic strains. New combinations were then produced through hybridization, and apomictic reproduction reappeared in a high proportion of the offspring. This gave true-breeding apomictic F_1 hybrids which remain uniform and vigorous in future generations and can be tested as varieties. We now have several hundred apomictic buffelgrass hybrids under study and some have survived 150 miles further north than present varieties. The winter-hardy buffels are about three weeks earlier than common in South Texas and some have produced nearly twice as much forage. We believe that these hybrids would be well adapted through Central Texas and that additional cold tolerance is possible.

We have succeeded in crossing buffelgrass with birdwoodgrass and putting the compact bur of birdwood on hybrids that look like buffel. These plants are exceptionally high in digestibility and are excellent seed producers. Preliminary tests indicate that the buffel-birdwood hybrids have considerable promise for range and pasture. A large nursery of buffel and buffel-birdwood hybrids is available for observation at the Texas A&M University Research and Extension Center at Dallas.

Weeping lovegrass

Sexual plants have recently been discovered in most of the grasses mentioned earlier, and you will soon see some interesting developments in these grasses. Dr. Paul Voigt, ARS Geneticist at the Woodward, Oklahoma Station has discovered sexual plants of weeping lovegrass and has crossed these with apomictic accessions. His objectives are improvement in forage quality and palatability and I feel certain that he will achieve these objectives.

Some recent developments in the selection of lovegrass strains should be mentioned. Morpa weeping lovegrass was developed and released jointly by the Oklahoma Experiment Station and ARS. It was selected for improved palatability, and grazing studies at Woodward showed a 12% improvement in animal gains over common weeping lovegrass. The variety has been released but seed supplies are limited.

Renner lovegrass was selected for improved palatability at the Texas Research Foundation at Renner (now Texas A&M University Research and Extension Center at Dallas). Comparative data for Renner and other weeping lovegrass varieties are not available, but good animal production on Renner was reported by the Texas Research Foundation. We are in the process of developing quantitative information on animal production and performance on Renner in comparison with Coastal bermudagrass. Also, forage quality is being assessed both in a grazing program and various agronomic studies. Renner lovegrass seed have been distributed in limited amounts and grower acceptance and responses to the variety are good.

Kleingrass

Kleingrass 75 is one of the most promising new grasses available for this area. It is a vigorous, drouth resistant, warm-season perennial bunchgrass released jointly by Texas Agricultural Experiment Station and the Soil Conservation Service in 1968. Kleingrass is an introduction from South Africa and is widely adapted in Texas. Kleingrass forage is much higher in nutritive value than Coastal bermudagrass, as evidenced by animal performance at several Research Centers. Seed shattering and the resultant shortage of planting seed is the main limiting factor in the use of kleingrass. It is rather difficult to establish but with adequate attention to seed bed preparation, planting depth, and weed control is the seedling stage, good kleingrass stands can be obtained.

Improved varieties of kleingrass may be expected in the future. We have selected strains for increased volume of seed and resistance to shattering. Forage quality studies of new strains indicate that dry

matter digestibility of kleingrass may be increased still further. Selections for increased digestibility and seed production are being tested at several locations this year.

In addition to its outstanding qualities for animal production, there is evidence that quail feed on the seed of kleingrass. We have recently initiated research to develop kleingrass with larger seed which should be especially useful for quail and perhaps have improved seedling vigor for pasture establishment.

Bermudagrass

The release of Coastal bermudagrass by Dr. Glenn Burton, over 20 years ago, stimulated new interest in the potential of this species and clearly demonstrated that we can develop forages with almost unlimited production capacity. In spite of its limitations, Coastal showed that bermudagrass has a place on many sites in the Southwest. The appearance of Coastcross-1 in 1968 verified the fact that forage quality can be improved through breeding, and that higher digestibility leads to significant improvement in animal performance. Lack of cold tolerance limited the use of this variety, but Coastcross-1 stimulated new research on the improvement of quality in perennial forage grasses. Demonstration that we can achieve such significant improvements in yield and quality represent two of the most outstanding advances in forage crop breeding.

Coastal is still the best available variety for much of this area but outstanding new varieties are on the way. We are testing a number of new hybrids derived from the basic breeding program at Stillwater, Oklahoma. Several of these are vigorous, rapid growing strains, equal to Coastcross-1 in forage quality, higher than Coastal in yield and apparently winter-hardy in most areas of Texas. The best hybrids are being increased this winter and we expect to begin testing them in grazing trials next summer. If our results of clipping studies and laboratory tests for quality are verified by animal performance, we expect to release an outstanding new variety for Texas from this material. The Oklahoma Experiment Station has recently released two new varieties derived from strains not included in our study.

We recognized the need for improvement of our native grasses but have not had the basic information or personnel to accomplish this task in the past. We anticipate that the new research program at Temple, Texas will devote considerable effort to improving native grasses.

Brush Control Research
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List of Major Accomplishments - 1964 to 1974

(See appended publications)

1. Weed and Brush Control

We have developed chemical control measures for the following species pending full registration of picloram or picloram plus 2,4,5-T herbicides.

	Species	Acres infested in Texas (millions)
1.	Live Oak (*Quercus virginiana* Mill.)	16.5
2.	Huisache (*Acacia farnesiana* (L.) Willd.)	2.6
3.	Whitebrush (*Aloysia lycioides* Cham.)	6.0
4.	Yaupon (*Ilex vomitoria* Ait.)	2.6
5.	Winged elm (*Ulmus alata* Michx.)	2.5
6.	Mixed hardwoods (East Texas)	-

We substantially contributed or are presently contributing control data for the following species:

	Species	Acres infested in Texas (millions)
7.	Honey mesquite (*Prosopis juliflora* (Swartz) DC. var. *glandulosa* (Torr.) Cockerell)	56.2
8.	Macartney rose (*Rosa bracteata* Wendl.)	1.0
9.	Post oak (*Quercus stellata* Wangenh.) and blackjack oak (*Quercus marilandica* Muenchh.)	11.3
10.	Cactus (pricklypear and tasajillo) (*Opuntia* spp.)	35.8
11.	Blackbrush (*Acacia rigidula* Benth.)	8.6

Honey mesquite, post oak and blackjack oak can be successfully controlled by 2,4,5-T. Other species listed are resistant or partially resistant to 2,4,5-T. Live oak, huisache, whitebrush, yaupon, and blackbrush cannot be controlled with 2,4,5-T, but can be controlled by picloram or picloram plus 2,4,5-T. Proper timing of herbicide application and formulation are extremely important in obtaining effective results. In brush control 2 to 3 years must elapse before final evaluations of kill can be made with confidence. Developing brush control measures may involve 5 years for a single species plus 5 years to refine the practice. If the species is resistant to chemicals, then other control measures such as mechanical must be considered. Research on honey mesquite has continued over 25 years and control measures developed are still less than ideal, but useable. Mechanical and combinations of chemical and mechanical brush control methods are being initiated. Several

new herbicides, such as tebuthiuron, are showing promise for brush control from soil and subsurface soil applications.

2. Herbicide Persistence and Loss

Considerable effort has been expended on picloram residue work in soils, plants, and water sources. This research has culminated in a Texas Agricultural Experiment Station Bulletin by R. W. Bovey and C. J. Scifres, entitled "Residual characteristics of picloram in grassland ecosystems." Picloram disappears from the ecosystem. Photodecomposition (sunlight) causes some loss. Leaching by rainfall effectively dilutes picloram in the soil profile. More work is needed to determine the exact fate of picloram in the soil. Recent work has involved the fate of 2,4,5-T and picloram in forages, soil, subsurface and surface runoff water.

3. Methods and Techniques

Gas chromatographic detection of picloram and 2,4,5-T in soils, plants, and water sources was developed by M. G. Merkle *et al.* Morton *et al.* compared the efficiency of radioisotopic and gas chromatographic methods for measuring absorption and translocation of 2,4,5-T by honey mesquite. Scifres, Bovey and Merkle compared bioassays and gas chromatography for detecting picloram in soils. Baur *et al.* developed a silylation technique to determine dicamba, 2,4-D and 2,4,5-T. New techniques will be developed as needed to accomplish the research.

4. Equipment and Engineering

Several useful laboratory, greenhouse and field sprayers have been developed to treat potted plants and field plots. Future research and equipment will be designed for improved placement of herbicides in or on soils and plant surfaces. L. F. Bouse has studied the drift potential of foam sprays versus conventional sprays. L. F. Bouse has also developed equipment in the laboratory for producing uniform drop-size sprays which will reduce spray drift and increase application efficiency in the field. J. B. Carlton is developing a program for the release of electrostatic charged sprays from aircraft to increase deposition on plant and soil surfaces.

5. Environmental Effects

Proper timing of herbicide applications is extremely important for successful brush control. Environmental factors and physiological condition of the plant interact to cause susceptibility or resistance to brush control treatments. Adequate soil moisture and good growing conditions are necessary for effective plant kill with herbicides.

6. Forage Production

Data on botanical composition changes and forage production after fire,

chemical or mechanical brush control is extremely important in order to justify control of a given brush problem. We have studied native forage production after brush control with herbicides and the tolerance of tame pasture species to commonly used herbicides in weed and brush control. Research work needs to be greatly expanded in this area.

7. Herbicide Effects on Crops

One of the main concerns of herbicide useage is the danger of injury to sensitive crops. Misuse of herbicides resulting in soil residues, contaminated water sources, and drift may cause injury to some field crops. Field research on the tolerance of grain sorghum and soybeans to picloram is being studied.

8. Absorption and Translocation

Research work in the past 10 years has given us a much better understanding of the uptake and distribution of herbicides in woody plants. For example, we have established the importance of root uptake of picloram in various woody plants as verified by gas chromatographic analysis. Some of the factors affecting foliar uptake and translocation of picloram and 2,4,5-T have also been established, such as herbicide mixtures, pH of the treating solution, type of brush, moisture stress, surfactants and carriers, etc. Studies are being continued. The use of various carriers and surfactants to improve woody plant kill has generally been disappointing. However, some experimental carriers have shown promise as slow evaporative carriers, and drift control agents, and for that reason should be investigated further.

9. Physiology and Mode of Action

Mode of action studies have not been given enough attention due to other pressing tasks, although considerable effort and time has gone into such studies (see journal list). J. R. Baur has worked on possible decarboxylation routes of picloram by plant cells and its incorporation and effect on various cell components. We have also studied the effects of dicamba, 2,4,5-T and picloram at the cellular level, using tissue cultures of crop and woody plant cells.

10. Anatomy and Morphology

Dr. R. E. Meyer has completed a study on anatomy and morphology of honey mesquite which is probably the most comprehensive of any available on a single woody species. He is presently studying the anatomy and morphology of Texas persimmon and possible reasons for its resistance to herbicides. Dr. Meyer is also completing a bulletin on the leaf and stem structure of 70 important Texas woody plants.

Dr. Meyer has reported on the anatomical and morphological effects of picloram and 2,4,5-T on honey mesquite seedlings.

11. <u>Miscellaneous</u>

Past work involved determination of the characteristics of natural occurring compounds in woody plants that are plant growth inhibitory substances. If pursued, this research could result in attaining a better understanding of basic plant processes and in developing new classes of growth regulators and herbicides. However, the work is difficult to interpret, time consuming and costly. We have discontinued our efforts in this area, at least for the present.

Major Bulletins and Journal Publications

Weed and Brush Control

1. Bovey, R. W., R. E. Meyer, F. S. Davis, M. G. Merkle, and H. L. Morton. 1967. Control of woody and herbaceous vegetation with soil sterilants. Weeds 15:327-330.

2. Bovey, R. W., F. S. Davis, and H. L. Morton. 1968. Herbicide combinations for woody plant control. Weed Sci. 16:332-335.

3. Bovey, R. W. and F. R. Miller. 1968. Desiccation and defoliation of plants by different herbicides and mixtures. Agron. J. 60:700-702.

4. Tschirley, F. H. *et al.* 1968. Response of tropical and subtropical woody plants to chemical treatments. Research Report CR-13-67. Agr. Res. Serv., U.S. Dep. of Agr. ARPA Order No. 424, U.S. Dep. of Defense.

5. Bovey, R. W. 1969. Effects of foliarly applied desiccants on selected species under tropical environment. Weed Sci. 17:79-83.

6. Bovey, R. W., C. C. Dowler, and J. D. Diaz-Colon. 1969. Response of tropical vegetation to herbicides. Weed Sci. 17:285-290.

7. Bovey, R. W., H. L. Morton, J. R. Baur, J. D. Diaz-Colon, C. C. Dowler, and S. K. Lehman. 1969. Granular herbicides for woody plant control. Weed Sci. 17:538-541.

8. Bovey, R. W., H. L. Morton, and J. R. Baur. 1969. Control of live oak by herbicides at various rates and dates. Weed Sci. 17:373-376.

9. Bovey, R. W., S. K. Lehman, H. L. Morton, and J. R. Baur. 1969. Control of live oak in south Texas. J. Range Manage. 22:315-317.

10. Dowler, C. C., F. H. Tschirley, R. W. Bovey, and H. L. Morton. 1969. Effect of aerially applied herbicides on Texas and Puerto Rican forests. Weed Sci. 18:164-168.

11. Meyer, R. E. and T. E. Riley. 1969. Influence of picloram granules and sprays on whitebrush. Weed Sci. 17:293-295.

12. Meyer, R. E., T. E. Riley, H. L. Morton, and M. G. Merkle. 1969. Control of whitebrush and associated species with herbicides in Texas. Tex. Agr. Exp. Sta. Misc. Pub. 930. 18 p.

13. Bovey, R. W., J. R. Baur, and H. L. Morton. 1970. Control of huisache and associated woody species in south Texas. J. Range Manage. 23:47-50.

14. Haas, R. H., S. K. Lehman, and H. L. Morton. 1970. Influence of mowing and spraying dates on herbicidal control of Macartney rose. Weed Sci. 18(1):33-36.

15. Meyer, R. E., H. L. Morton, M. G. Merkle, R. W. Bovey, and F. S. Davis. 1970. Brush control in the east Texas timberlands. J. Range Manage. 23:129-132.

16. Bovey, R. W., R. E. Meyer, R. D. Baker, and J. R. Baur. 1972. Evaluation of polymerized herbicides for brush control. Weed Sci. 20(4): 298-302.

17. Bovey, R. W., H. L. Morton, R. E. Meyer, T. O. Flynt, and T. E. Riley. 1972. Control of yaupon and associated species. Weed Sci. 20:246-249.

18. Meyer, R. E. and R. W. Bovey. 1973. Control of woody plants with herbicide mixtures. Weed Sci. 21:423-426.

Herbicide Persistence and Loss

19. Merkle, M. G., R. W. Bovey, and F. S. Davis. 1967. Factors affecting the movement and persistence of picloram in soil. Agron. J. 59:413-414.

20. Morton, H. L., E. D. Robison, and R. E. Meyer. 1967. Persistence of 2,4-D, 2,4,5-T and dicamba in range forage grasses. Weeds 15:268-271.

21. Trichell, D. W., H. L. Morton, and M. G. Merkle. 1968. Loss of herbicides in runoff water. Weed Sci. 16:447-449.

22. Bovey, R. W., C. C. Dowler, and M. G. Merkle. 1969. Persistence and movement of picloram in Texas and Puerto Rican soils. Pesticide Monit. J. 3:177-181.

23. Bovey, R. W. and C. J. Scifres. 1971. Residual characteristics of picloram in grassland ecosystems. Texas Agr. Exp. Sta. Bul. 1111. 24 p.

24. Baur, J. R., R. D. Baker, R. W. Bovey, and J. D. Smith. 1972. Concentration of picloram in the soil. Weed Sci. 20:305-309.

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31. Morton, H. L., F. S. Davis, and M. G. Merkle. 1968. Radioisotopic and gas chromatographic methods for measuring absorption and translocation of 2,4,5-T by mesquite. Weed Sci. 16:88-91.

32. Ketchersid, M. L., R. W. Bovey, and M. G. Merkle. 1969. The detection of trifluralin vapors in air. Weed Sci. 17:484-485.

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Equipment and Engineering

35. Bouse, L. F. and R. W. Bovey. 1967. A laboratory sprayer for potted plants. Weeds 15:89-91.

36. Meyer, R. E., H. L. Morton, and T. O. Flynt. 1967. A truck sprayer for applying chemicals to brush. Weeds 15(3):286-287.

37. Bouse, L. F., H. L. Francis,and R. W. Bovey. 1970. Design of a pesticide sprayer for the laboratory. USDA-ARS Bul. 42-165. 18 pp.

38. Flynt, T. O., R. W. Bovey, J. R. Baur, and R. E. Meyer. 1970. Two tractor sprayers for applying herbicides to brush. Weed Sci. 18:497-499.

39. McCall, H. G., R. W. Bovey, and J. R. Baur. 1970. A spray device for applying chemicals to small plants. Weed Sci. 18:549-550.

40. Flynt, T. O., T. E. Riley, R. W. Bovey, and R. E. Meyer. 1971. Auger soil sampler for herbicide residues. Weed Sci. 19:583-584.

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Herbicide Effects on Crops

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56. Bovey, R. W. and F. R. Miller. 1969. Effect of activated carbon on the phytotoxicity of herbicides in a tropical soil. Weed Sci. 17:189-192.

57. Miller, F. R. and R. W. Bovey. 1969. Herbicidal tolerance in *Sorghum bicolor* (L.) Moench. Agron. J. 61(2):282-285.

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60. Scifres, C. J. and R. W. Bovey. 1970. Differential response of sorghum seedling varieties to picloram. Agron. J. 62:776-778.

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61. Bovey, R. W., F. S. Davis, and M. G. Merkle. 1967. Distribution of picloram in huisache after foliar and soil applications. Weeds 15:245-249.

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65. Swanson, C. R. and J. R. Baur. 1969. Absorption and penetration of picloram in potato tuber discs. Weed Sci. 17:311-314.

66. Baur, J. R. and R. W. Bovey. 1970. The uptake of 4-amino-3,5,6-trichloropicolinic acid (picloram) by potato tuber tissue. Weed Sci. 18:22-24.

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RESEARCH RELATING TO SCS NEEDS

TEMPLE, TEXAS

Earl Burnett

The Blackland Conservation Research Center is a cooperative activity between ARS and TAES. Our research program is focused on soil management, soil erosion, soil fertility, crop production, and watershed problems of four major land resource areas: (1) Blackland Prairie, (2) Grand Prairie, (3) Edwards Plateau, and (4) Texas Claypan area, with major emphasis on soil-plant-water relations of swelling clay soils. Studies of the effects of modern agricultural practices on possible pollution of soils and runoff water by sediment and chemicals are also carried out. While research on efficient production of grain sorghum and cotton continues to be an important part of our research effort, we are devoting considerable time to grass and forage problems because forages are becoming increasingly important in the region served by this Center.

The research objectives and recent results are presented in six sections:

Predicting Runoff and Streamflow

Sediment Transport and Yield from Agricultural Watersheds

Water Erosion Control Practices for the Texas Blackland Prairie

Soil-Plant-Atmosphere Relationships for Efficient Use of Water and Energy

Nitrogen Balance and Fertilizer Use Efficiency

Fate of Agricultural Chemicals Applied to Agricultural Watersheds

Predicting Runoff and Streamflow

The objectives of this research are to determine the hydrologic effects of agricultural management practices and to develop models for predicting runoff from agricultural watersheds that can be used as design and management tools. These broad objectives include the following specific objectives:

(1) To determine the effects of agricultural practices in the Blackland Prairie of Texas on the amounts and frequency of flood flows and water yield.

(2) To develop methods of predicting components of the water balance on small source areas for different crop and management alternatives.

(3) To develop techniques for predicting runoff hydrographs from agricultural watersheds of ten square miles or less.

(4) To develop techniques for routing hydrographs through streams and valleys of large watersheds.

(5) To develop methods of predicting long-term water yield from ungaged agricultural watersheds.

(6) To develop stochastic models of meteorological processes (precipitation, solar radiation, etc.) so that long meteorological records can be generated for input to deterministic hydrologic models.

Progress has been made in several areas related to predicting runoff and streamflow. These accomplishments will be summarized under several subjects.

(1) Runoff amounts and frequencies

Agricultural practices can have significant effects on runoff from small watersheds. An intensive conservation program on a small watershed resulted in a 24% reduction in runoff from the area compared to what was expected in the pre-treatment conditions. The intensity of agronomic treatment was found to have a greater effect on amounts of runoff than conservation structures.

A method was developed for determining the effects of agricultural practices on the storage requirements of small reservoirs. The change in reservoir storage requirement due to watershed treatment was found to be dependent on the design probability level and withdrawal rate. Land use was shown to be an important consideration in determining reservoir size.

(2) Hydrograph development

A procedure was developed for computing single-peaked hydrographs from small watersheds in the Texas Blackland Prairie. The two-parameter gamma function was used to describe the hydrograph to the inflection point and a first order decay equation described the recession curve. To compute a hydrograph the recession constant and time to peak must be predicted. These two time variables were related to easily determined watershed characteristics. The predicted hydrographs compared closely with measured single-peak hydrographs from nine small Blackland watersheds (0.5 to 18 sq. mi.).

A storage depletion procedure was developed to compute hydrographs from complex storms on small watersheds. Inputs to the procedure are simple and easy to obtain. Multi-peaked hydrographs can be computed quickly, even with a desk caluclator. Hydrographs computed by the storage depletion procedure compare closely to those measured from 15 watersheds. The storage depletion approach is more rapid and may be as accurate as the traditional convolution approach to hydrograph computation.

(3) Predicting runoff from source areas

Soil water has a major effect on the amount of surface runoff resulting from rainfall. A water balance model has been developed that predicts daily soil water on a continuous basis for use in runoff prediction. The model predicts daily plant and soil evaporation, drainage, and soil water using daily atmospheric variables, plant parameters, and soil characteristics. Measured precipitation minus measured runoff is used as input to soil water storage to avoid errors introduced when runoff is neglected. Estimates of plant leaf area index values are used to determine the relation between daily potential evaporation and daily plant evaporation. Parameters based on physical characteristics of the soil are used in computing soil evaporation and in defining when soil water becomes limited. Soil water computed with the model for a small watershed over a 3-year period compared closely with measured soil water.

An optimization technique was developed to compute hydrologic variables that cannot be measured directly. Measured rainfall rates and storm hydrographs from complex storms are used to compute unit hydrograph shapes and associated source runoff. The computed unit hydrographs can be used to develop relationships between unit hydrograph shape parameters and storm and watershed characteristics. The computed incremental source runoff can be used to develop and test infiltration equations for watersheds. Such equations should be more accurate in predicting source runoff from watersheds than equations developed with infiltration data.

Two methods were developed for determining SCS runoff curve numbers to apply to long term rainfall series. The procedures can be used to compute water yield or a flood series for evaluation of flood control programs. They are also useful in determining the long-term average curve number for gaged watersheds. One procedure uses a first order decay function to deplete a soil moisture index between storms according to daily temperature. The soil moisture index is defined as the curve number divided by ten. The depletion coefficient is optimized to compute average annual runoff that agrees with measured or estimated average annual runoff. With the second procedure a curve number frequency distribution is required. The simulation rejection technique is used to determine curve numbers to apply to a rainfall series. This procedure optimizes a parameter of the curve number frequency distribution to compute average annual runoff that agrees with a given amount. The two procedures have performed well in limited testing.

(4) Flood routing

A Variable Travel Time (VTT) method of routing hydrographs through streams was developed that accounts for the variation in travel time as a hydrograph passes through a routing reach. Prior storage routing methods did not account for the change in travel time with stage of flow because correct volume could not be maintained throughout the routing. The VTT method maintains correct volumes, increases accuracy of storage routing, and is applicable to a wide variety of watershed conditions.

The VTT flood routing method was modified to include the effects of a changing water surface slope during a flood. The new VTT method is about as accurate as an implicit solution to the unsteady flow equations of continuity and motion, and has the general applicability of simpler storage methods. Although an iterative solution is required, the VTT method requires little computer time and is free of convergence problems.

A problem-oriented computer language was developed to model runoff from watersheds. The language is called HYMO from the words "hydrologic model." Hydrologists unfamiliar with computer programming can use HYMO to great advantage in watershed modeling. HYMO provides 17 commands, commonly used in hydrology, to transform rainfall into runoff hydrographs and to route these hydrographs through streams and valleys or reservoirs. These functions make HYMO useful in the design and evaluation of flood control structures, flood forecasting, and research. The input data required for HYMO are easy to obtain for most watersheds. HYMO can easily be expanded by adding new commands or modifying present commands.

Sediment Transport and Yield from Agricultural Watersheds

The objectives are to develop models for predicting sediment transport and yield from agricultural watersheds. The models must be accurate, efficient, generally applicable, and have practical input requirements. Models are needed to:

(1) Predict total sediment yield from small watersheds with areas less than ten square miles.

(2) Route sediment yield from small watersheds through streams and valleys to permanent streams and reservoirs.

(3) Determine long-term sediment yield for small and large watersheds.

(4) Predict sediment graphs (time distribution of sediment) for individual storms on small watersheds.

(5) Route sediment graphs through streams and valleys to permanent streams and reservoirs.

(6) Determine large watershed optimal operating policies within constraints imposed by water quality standards.

Recent accomplishments include the following:

(1) Multivariate analysis was used to develop an equation for predicting the average sediment concentration of individual storms. The relatively independent factors of the equation were represented by the unterraced cultivated area, weighted rainfall intensity, runoff rate and volume, soils, total rainfall, and the hypsometric integral. The equation explained about 63 percent of the variation in sediment concentration for five small Blackland watersheds.

(2) An equation was developed for predicting sediment concentration from rangeland watersheds. The relatively independent factors of the equation are range condition, drainage density, and main stem slope. The equation explained about 78 percent of the variation in sediment concentration for four rangeland watersheds in the Edwards Plateau of Texas.

(3) The Universal Soil Loss Equation was used with a delivery ratio to predict sediment yield from watersheds. The factors of the equation were weighted on an area basis to increase computational efficiency. The erosion-control-practice factor was expanded to include the separate effect of grassed waterways. Delivery ratios were computed for five small Blackland watersheds and related to watershed characteristics.

(4) The Universal Soil Loss Equation was modified by replacing the rainfall energy factor with a runoff factor (the product of the runoff volume and the peak rate). The runoff factor increased the accuracy of the equation and eliminated the need for a delivery ratio. Non-linear least squares was used to develop the equation with data from 18 small watersheds at Riesel, Texas and Hastings, Nebraska. The equation explained about 92 percent of the variation in sediment yield for 778 individual storms. The equation has been tested with data from Treynor, Iowa; Oxford, Mississippi; and Chickasha, Oklahoma. Prediction accuracy was uniform for all watersheds tested ($R^2 > 0.80$).

(5) The Modified Universal Soil Loss Equation was used with frequency analysis to determine long-term sediment yields. Sediment frequency curves are computed from runoff frequency curves and the factors of the Universal Equation. The area under the sediment frequency curve is the average annual sediment yield. Man's effect on long-term sediment yield from agricultural watersheds can be determined by manipulating the cropping management and erosion-control-practice factors of the Universal Equation.

(6) A sediment routing model was developed to route sediment yield from small watersheds through streams and valleys of large watersheds. The routing equation, a first order decay function, depletes the small-watershed sediment yield according to travel time and particle size. The locations and amounts of flood plain deposition and scour can be determined. Also, the total sediment yield can be predicted more accurately by subdividing a large watershed and routing than by considering the entire watershed in one prediction. Routing also allows determination of subwatershed contributions to total sediment yield.

(7) A sediment graph computation procedure was developed to compute the time distribution of sediment for individual storms. A unit sediment graph similar to a unit hydrograph is convolved with source runoff to produce the storm sediment graph. The unit sediment graph is defined as the amount of sediment produced by one inch of runoff on the watershed. Unit graphs will vary seasonally because of changing cover conditions on the watershed and differences in runoff rates. The shape of the unit sediment graph is defined by the two-parameter gamma function to the inflection point, and then by a first order decay function. Sediment graphs should be useful in water quality modeling because they show the variation in sediment rate during a storm.

Water Erosion Control Practices for the Texas Blackland Prairie

There are two primary methods of reducing soil erosion: (1) structural means that control the velocity of runoff water, and (2) agronomic means that protect the soil from the erosive forces of rainfall impact. The objective of this study is to develop systems that combine the most effective structural and agronomic measures in such a way that maximum production, efficient tillage, and minimal erosion are achieved. The objectives include the following:

(1) To find methods of modifying land slope so that nonerosive velocities of runoff are maintained.

(2) To investigate a system of graded furrows as an erosion control method.

(3) To determine the effects of furrow slope and length on runoff and erosion.

(4) To determine runoff, erosion, crop yields, and machinery operation efficiency of graded furrow systems relative to that of conventional terrace systems.

(5) To test the effects of deep tillage on erosion characteristics of Blackland Prairie soils.

(6) To determine the influence of plant spacing on runoff, erosion, and crop yield.

(7) To determine the influence of several tillage systems on runoff, erosion, and yield of grain sorghum with narrow (27-inch) row spacing.

Recent accomplishments include the following:

(1) Graded furrows with a 40-inch row spacing and a uniform 1% slope have controlled soil erosion within permissible limits. Runoff and soil loss per unit area was found to increase as furrow length increased. The maximum row length for a graded furrow system was found to be about 1,000 feet. Crop yields from graded furrow systems were comparable to yields from conventional systems.

(2) Design criteria have been developed for graded furrow systems. Furrow grades are allowed to vary from 1% as a maximum to a minimum determined as a function of distance from the upper end of the furrow. Because the furrow grade is allowed to vary, the graded furrow system is adaptable to a wide range of fields.

(3) Tillage rates were 21% faster on a field with a graded furrow system than on a field with a terrace system. Runoff and erosion from the graded furrow system was essentially equal to that from a conventional terrace system.

(4) Laboratory studies of the residual effects of crop rotations on water intake and soil loss showed that oats-grain sorghum and fescuegrass-grain sorghum rotations significantly increased water intake and reduced soil loss for 20 months after the rotations were discontinued. A sweetclover-grain sorghum rotation had no effect on soil loss but had a significant residual effect on water intake for 8 months after the rotation was discontinued.

(5) A grain sorghum field with graded furrows and closer row spacing (20 inches) had less soil and water loss and higher grain yield than a grain sorghum field with graded furrows and 40-inch row spacing. In 1973, grain sorghum with 20-inch row spacing reduced runoff 1.1 inches, or 47%, compared to grain sorghum with 40-inch row spacing. During an erosive storm in June 1973, two weeks before pollination, a grain sorghum field with 20-inch row spacing lost 42% less soil than a grain sorghum field with 40-inch row spacing. In the closer row plantings it was observed that the plant canopy more completely covered the soil surface. Grain yield in 1973 was increased 9% with 20-inch row spacing.

Soil-Plant-Atmosphere Relationships for Efficient Use of Water and Energy

The objectives are:

(1) To develop and test useful models for predicting the water and energy balance in agricultural plant communities as influenced by the interdependent dynamic soil-plant-atmosphere system.

(2) Use the models to

(a) develop plant spacing systems that bring about beneficial changes in the use of water and energy

(b) predict the major components of the water balance on watersheds

(c) predict vegetative and economic yields of major crops grown in the Texas Blackland Prairie and adjacent land resource areas.

(3) Use the models as an aid in defining critical research needs where fundamental understanding is lacking.

The influence of atmospheric, plant, and soil water factors on evaporation from row crop canopies has been quantitatively evaluated under field conditions. A version of Penman's equation has been found satisfactory for combining atmospheric variables into an equation for estimating potential evaporation. If soil water is "freely" available to plant roots, the plant influences the transpiration rate through the leaf area index. A threshold leaf area index has been defined to describe when an expanding canopy becomes large enough to evaporate at potential evaporation rates. Plants growing in a field environment were found to respond to soil water deficits in a quite different manner than classical studies using container grown plants had indicated, principally because of the dynamic nature of roots grown in natural, deep soils. When plants were allowed to dry the soil to the minimum possible water content (approximate wilting point), decreased transpiration occurred only for the last 2025% of the total extractable soil water, regardless of the evaporative demand.

The evaporation research findings have been integrated with information from other locations into a new approach for predicting the daily evaporation rate from row crops with partial cover in which the evaporation rate from the soil and plants is evaluated independently. The prediction procedures have already been integrated into growth simulation models for corn (SIMASE) and cotton (SIMCOT) developed by scientists in the USA and will soon be integrated into a widely used computer model for assisting farmers in irrigation scheduling. The evaporation prediction technique has also been used to develop a water balance model for small watersheds. This latter procedure has predicted daily soil water amounts that are in close agreements with measurements on watersheds at Riesel, Texas and Chickasha, Oklahoma.

A model has been developed and tested for predicting the amount of sunlight intercepted by a plant canopy. The model takes into account the plant row spacing, plant population, leaf area index, and sun angle. This model has been used to compute potential photosynthesis (dry matter produced) and effective ground cover. The benefits of improved light interception by narrow row grain sorghum have been quantified using the model. A quantitative assessment of the reduction in evaporation during first stage drying resulting from different amounts of ground cover was possible using the model.

A model was developed for predicting grain sorghum leaf area throughout the growing season on a daily basis. The model uses plant density and daily air temperature as inputs. Rate of appearance of leaves on the plant and rate of leaf expansion make possible a reliable estimate of the LAI throughout a growing season. LAI information was a needed input parameter for the light interception model and can be used in the ET model requiring LAI input. LAI measurements are frequently unavailable and always time consuming to obtain. The model predicted LAI values for three locations in the Great Plains that were in good agreement with measured values.

Diurnal leaf expansion rates and grain kernel expansion rates of grain sorghum have also been characterized in relation to microenvironmental conditions and plant water status. Leaves were expanding when leaf water potentials were about -15 bars, a result that differes considerably from classical literature where work was done in growth chambers.

Field plot studies at Temple have shown an increase in grain sorghum yield with closer row spacing, when weeds are controlled. Increases in grain yield with row spacing vary from about 12% with 75-cm row spacing to approximately 25% with 25-cm row spacing compared to grain yield with conventional 100-cm row spacing. Plant population was maintained at 194,000 plants/ha with all row spacings. Soil water measurements have shown no significant differences in soil water between row spacing treatments during, or at the end of the growing season. Therefore, soil water is used more efficiently in the closer row spacing.

Runoff and erosion studies in 1973 showed that grain sorghum with 50-cm row spacing had 2.5 cm more water intake and 2,500 kg per hectare less soil loss than grain sorghum with conventional 100-cm row spacing. Fertilizer use also appears to be more efficient with close row spacing of grain sorghum. Exploratory studies in 1973 showed that increasing fertilizer N from 78 to 146 kg/ha increases grain yield about 30% with 100-cm row spacing and about 55% with closer (50-cm) row spacing.

Closer row spacing also caused a significant increase in the number of shrinkage cracks developing at the soil surface. Shrinkage cracks tend to be narrower with closer row spacing, both parallel and perpendicular to the plant row. However, lysimeter studies have shown that evaporation from shrinkage cracks is a minor source of water loss in a field scale.

Field studies show that close row spacing of grain sorghum reduces evaporation of soil water during first stage drying. In 1973, during the 6- to 8-leaf vegetative stage of grain sorghum, evaporation of soil water from 25- and 50-cm row spacing was approximately 1/3 and 2/3 respectively, of evaporation under sorghum with 100-cm row spacing. At this stage of growth about 25, 50, and 75% of the soil surface was shaded with row spacings of 100, 50, and 25 cm, respectively. Grain sorghum with closer row spacing establishes an earlier and a more complete canopy, which shades more of the soil surface from early vegetative growth to maturity. The decreased penetration of radiant energy to the soil surface reduces evaporation of soil water during first stage drying. Soil water saved by reduction of evaporation also may be a factor affecting yield of grain sorghum with close row spacing.

Nitrogen Balance and Fertilizer Use Efficiency

Earlier research showed that leaching losses of applied N fertilizer could be significant on swelling clay soils. The objectives of this project was therefore directed toward understanding the mechanism of leaching in these soils and quantifying actual N leaching losses. In addition, losses of nitrate in surface storm runoff was measured on two watersheds. These studies showed that losses of applied N by leaching or runoff were not the major factors causing N fertilizer inefficiency. Therefore, a complete N balance under field conditions was undertaken to determine the pathways of fertilizer N loss and establish the reasons for poor N fertilizer efficiency.

In the past, it had been thought that drainage below the root zone of swelling clay soils was negligible, and consequently there would be no nitrate leaching. In a recent water balance study, we have estimated that there is a potential for 9 cm drainage flux during April and May in years with average rainfall. It was noted that the saturated hydraulic conductivity of Houston Black clay in field basins was 2.5 cm/day. Where the soil is near saturation and rainfall rates are 2.5 cm/day or more, the drainage flux could therefore approach 2.5 cm/day if rain intensity was not excessive. It also was noted that saturated hydraulic conductivity of large undisturbed cores was much reduced when compared to conductivity values measured in the field. Disturbing and repacking the soil into columns reduced the hydraulic conductivity even further. Use of fluorescein dye as a tracer for water movement showed that much of the water flowed through relatively large connected soil pores. Many of the nonvertical pores were cut off in undisturbed cores, especially long cores with a small diameter.

The relatively large connected soil pores also were found to be important pathways in the leaching of nitrate through swelling clay soils. Water was tagged with both fluorescein dye and Cl^- and allowed to flow through field basins. The results showed that the soil was highly enriched with Cl^- in the connected soil pores where the fluorescein dye concentrated during water flow. Chloride was eluted at a lower fraction of the total pore volume from short cores than longer cores, indicating that many of the large connected pores that carry water and salt are not vertical. Therefore, undisturbed cores that more nearly represent field conditions are those that have a diameter considerably greater than their length.

The results of these studies clarified the mechanism of nitrate movement. Nitrates present in the upper layer of soil near field capacity can be leached through swelling clay soils as excess soil water carries nitrates from the plow layer into natural fissures between structural units. This solution then bypasses other water in the pores within the soil structural units that is lower in nitrate content than the percolating solution. In other related work we found that for a swelling clay soil, overburden pressure from the upper layers of soil has an important influence on water and Cl^- movement through soil beneath the plow zone. When overburden pressure was removed, saturated flow rates increased. Subsequent miscible displacement studies revealed that the apparent soil water excluding Cl^- was reduced from 50% to 35% of the total pore volume after removal of overburden pressure.

Nitrate leaching losses in the field have been measured during the past 2 years utilizing an undisturbed drainage lysimeter. Results for 1972 showed that N fertilizer applied to a wet soil began to be leached below the potential crop root zone with the first large rainstorm. Losses of applied N fertilizer were not great until large amounts of water had drained below the root zone. The results of this study indicated that 90 mm of drainage through the zone of fertilizer placement would leach about 8% of the applied nitrate below the root zone. More recent results from a N balance study in the field showed that 2% of the applied N fertilizer was leached below the root zone by 94 mm of drainage. These results show clearly that N leaching is not a major cause of poor N fertilizer efficiency in swelling clay soils. Other results from the N balance study indicated that immobilization of about 30% of the applied N was responsible for some of the disappearance of nitrate from the soil. By difference it was estimated that about 15% of the applied N was denitrified.

Nitrate losses in surface storm runoff have been measured on two watersheds at Riesel since 1970 In general, losses of nitrate by this pathway have not been important in reducing N efficiency. However, if fertilizer is applied to a soil that is near field capacity, subsequent storms can produce runoff that contains high concentrations of nitrate.

The efficiency of N utilization by summer growing perennial forages such as coastal bermudagrass is often lower than for row crops. For this reason, N fertilization of improved summer pastures has been quite low in the Blacklands and many pastures have experienced declining production after establishment. Despite low N efficiency, yields of forage can be quite good and profitable up to 400 lb N per acre, depending on the soil and other management factors. In this study, different sources of N, including some sulfur coated ureas (SCU), were compared with respect to their N efficiency and the dry matter produced. In general, a single application of SCU produces the same total yeild as a single application of urea or ammonium nitrate but gives a better distribution of yield and protein through the growing season. However, split applications of ammonium nitrate give slightly better total yield and improved distribution of yield and protein when compared to a single application of SCU.

We have found that losses of N as ammonia from surface applied ammonium sulfate and diammonium phosphate were considerably greater than from ammonium nitrate. A mechanism has been proposed to explain this difference. The solubility of the reaction product from the applied ammonium compound and $CaCO_3$ was found to be the main factor influencing ammonia loss.

A coastal bermudagrass pasture located on a Grayland soil was found to respond well to fertilizer only when the soil was chiseled prior to fertilizer application. Apparently, improved infiltration of water and movement of nutrients into the soil caused the improved yields.

Fate of Agricultural Chemicals Applied to Agricultural Watersheds

The objectives of this research are to:

1. Determine the fate of certain herbicides applied to agricultural soils.

2. Determine nitrate losses in surface and subsurface flow from heavy clay soils.

3. Determine arsenic in runoff water from cotton fields treated with arsenic acid as a desiccant.

4. Determine fate of certain insecticides applied to agricultural soils.

Five spray applications with mixtures of the triethylamine salts of (2,4,5-trichlorophenoxy) acetic acid (2,4,5-T) + 4-amino-3,5,6-trichloropicolinic acid (picloram) at 0.56 + 0.56 kg/ha were made every 6 months on the same watershed. Herbicide content in the Houston Black clay soil from May 4, 1970 to May 5, 1972, remained low (0 to 268 ppb). Herbicide content on grass was high (50,000 to 70,000 ppb) immediately after spraying but degraded rapidly after each treatment and did not accumulate in plants or soil. Plant "wash-off" was the main source of herbicide detected in runoff water. Concentration of herbicide in runoff was moderately high (400 to 800 ppb) if heavy rainfall occurred immediately after treatment, but low (< 5 ppb) if major storms occurred one month or longer after treatment. Concentration of 2,4,5-T and picloram in seepage and well water from the treated area was extremely (< 1 ppb) during the 3-year study. No 2,4,5-T was detected from 122 drainage samples from a field lysimeter (4 feet deep) sampled for 1 year after treatment with 1.12 kg/ha of 2,4,5-T + picloram (1:1). Picloram was detected in small amounts (1-4 ppb) in water percolating through the lysimeter 2 to 9 months after application. No damage occurred to cotton (Gossypium hirsutum L.) or sorghum (Sorghum bicolor (L.) Moench) from either spray drift or subsequent runoff water in a field adjacent to and below herbicide treated areas.

Arsenic acid is commonly used in the Texas Blacklands as a cotton desiccant to facilitate harvest. In 1971, approximately 2 million acres were treated with arsenic acid. A study was initiated on six small watersheds to determine arsenic levels in surface runoff. The cropping sequence on the watersheds is a three year rotation of cotton, grain sorghum, and oats. Arsenic acid is applied as a desiccant during the cotton year of the rotation.

Arsenic concentrations in surface runoff before treatment in 1972 ranged from 5 to 20 ppb. Arsenic levels in runoff water following 1972 application of arsenic acid were 150 to 350 ppb from the treated watersheds and less than 20 ppb from untreated watersheds. The elevated arsenic content on the treated watersheds was evident through the third runoff producing storm following the application of arsenic acid. The transport of arsenic acid in surface runoff appears to be related to the period of time and the climatic conditions existing during the period between application and runoff. Soil samples were taken to determine arsenic concentrations by depth. Statistical tests showed significant arsenic accumulation in the 0-6 inch depth over the natural occurrence of arsenic in the soils. Arsenic has accumulated in the 612 inch depth but concentrations are not significantly higher than natural occurrence.

The movement of nitrogen fertilizer in surface runoff has been st died since 1970 on two 10acre cultivated watersheds. Nitrogen fertilizer was applied to each watershed at a rate of 60 to 90 lbs per acre each year. Nitrogen concentrations in surface runoff have been monitored during all runoff producing storms. Losses of nitrogen in surface storm runoff have been small compared to the amount applied (1 to 4 lbs/acre per year), yet concentrations of NO_3^--N have occasionally exceeded 10 ppm, being as high as 50 ppm during isolated storms.

Loss of DDT and toxaphene in surface runoff water in the Blackland Prairie is low relative to the amount applied. The first year after applying DDT, samples of runoff water indicated only 0.58 lb was lost in surface runoff. Twice as much toxaphene was lost during the same period, which is in accord with the normal 2:1 toxaphene-DDT application rate. DDT isomers DDE and o,p-DDT were in approximately the same concentrations and only half as high as p,p-DDT. Toxaphene has not been found to percolate through the soil profile with seepage effluent in the Texas Blackland Prairie soils. The small amount of toxaphene that infiltrates into the soil is held within the profile and does not leach out. Concentrations of DDT (all isomers) in seepage flow relates well to time after application that seepage occurs and seepage rate. Only one sample has shown greater than 0.6 ppb of DDT. The DDT isomer concentrations in seepage flow indicated DDE is half that for o,p-DDT, which is half that for p,p-DDT.

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EXPERIMENTS BEING CONDUCTED IN SOIL AND WATER RESEARCH,
ARS, Weslaco, Texas

(Outline for SCS-ARS Workshop, Ft. Worth, April 16-18, 1974)
C. L. Wiegand

Soil management

The effect of narrow trenching for increased root proliferation and moisture efficiency on Harlingen clay. (Heilman and Gonzalez)

Soil nitrification in relation to land forming. (Thomas)

Water management

Irrigation scheduling with the Jensen-Haise method in the Lower Rio Grande Valley. (Salinas and Namken)

Sprinkler and furrow irrigation of vegetables. (Salinas)

Effects of irrigation regime, and plant population in sugarcane production. (Thomas and Salinas)

Use of saline ground waters for supplemental irrigation of sugarcane. (Thomas)

Water requirements of Marrs oranges, red blush grapefruit, and Valencia oranges in the Rio Grande Valley. (Wiegand)

S-T-R-E-T-C-H-I-N-G water supply for citrus by suppressing evaporation. (Wiegand)

Soil-water-plant relations of irrigated Cynodon grass species as influenced by: (1) depth to saline water table, (2) irrigation regime, and (3) nitrogen fertilizer. (Namken)

Evapotranspiration in the Rio Grande Valley. (Nixon)

Influence of plant water stress on growth and evapotranspiration. (Namken)

Alternate row planting and irrigation practices for short season cotton. (Namken)

Testing of materials for improved subsurface drainage. (Rektorik)

Reclamation of a saline-alkali depressional area Combes loam soil using a well point drainage system. (Rektorik)

Drainage of a Raymondville clay loam with manifold well points. (Rektorik)

Well point system design for uniform field drainage. (Rektorik)

Plant management

Mechanical manipulation of native brushland for herbaceous forage production. (Gonzalez)

Variety, row spacing and date of planting influences on economical cotton production systems in the Lower Rio Grande Valley. (Heilman and Namken). Sponsored by Cotton Incorporated. Substudies as follows:

Irrigation requirements of early maturing cotton varieties in the Lower Rio Grande Valley of Texas. (Namken) Study I.

Variety and row spacing study. (Heilman) Study II.

Effect of planting date on yield and fruiting characteristics of different cotton varieties. (Namken and Heilman) Study III.

Plant population and fruiting characteristics. (Namken and Heilman) Study IV.

Micrometeorological and microclimatological investigation of conditions occurring in a citrus grove during periods of potential freeze. (Nixon)

Presented by: C. L. Wiegand, Weslaco, Texas at the SCS, ARS, Workshop Ft. Worth, Texas April 16-18, 1974.